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Westinghouse automat

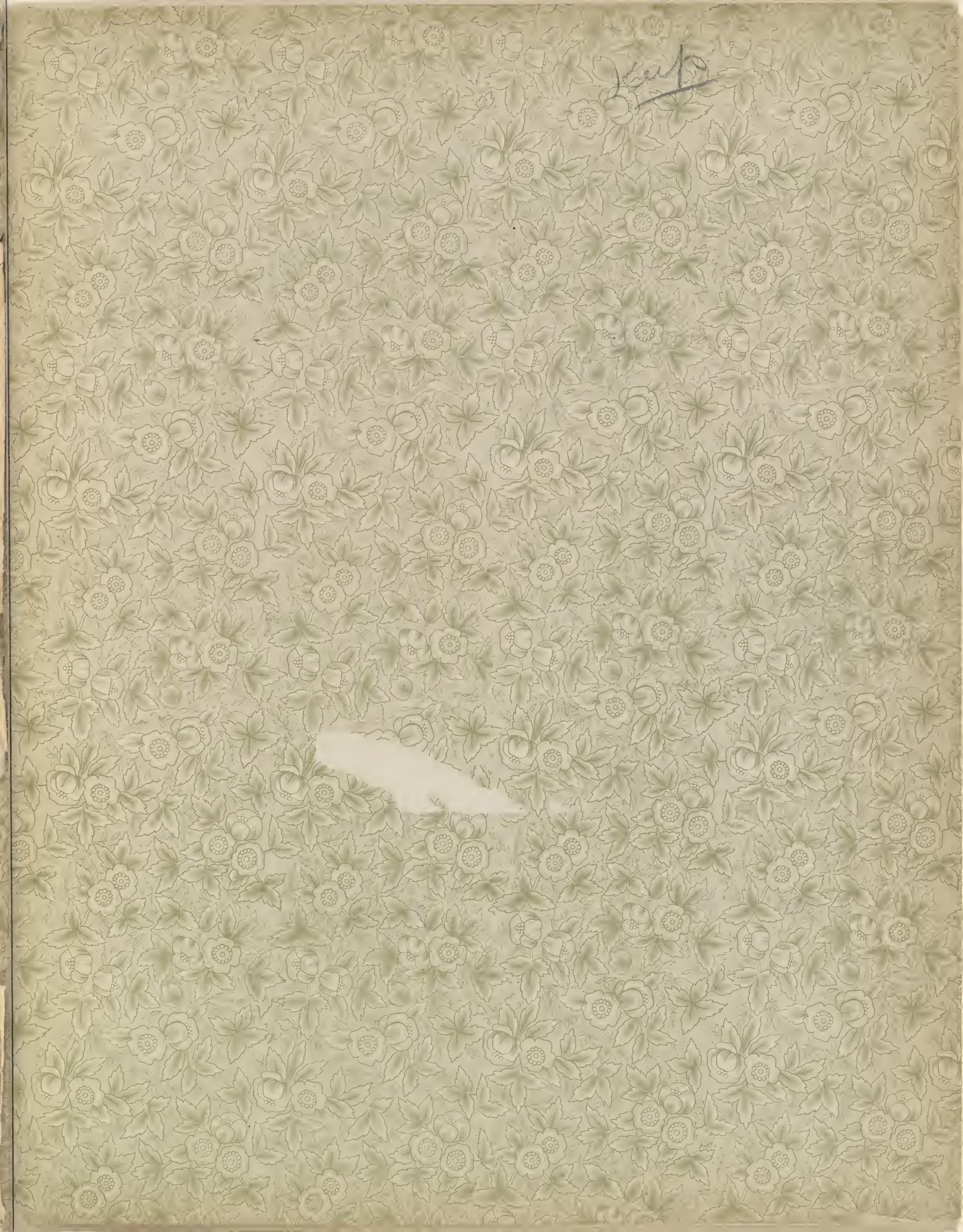
WESTINGHOUSE
AIR BRAKE CO.
1886

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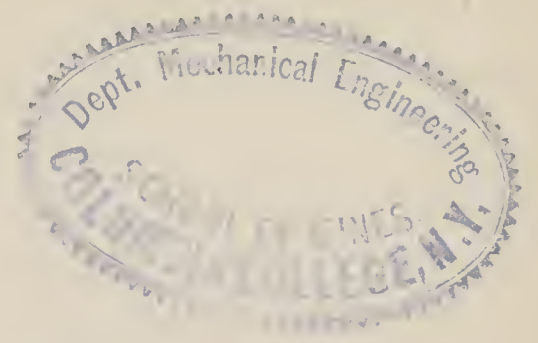


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To: Prof. J. R. Hutton
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J. Westinghouse 12/4/87



THE

Westinghouse Air Brake Co.

PITTSBURGH, PA.

Office and Works: Robinson, Lacock, and Darragh Streets,
Allegheny City, Pa.

OFFICERS:

GEO. WESTINGHOUSE, Jr., President.	JOHN CALDWELL, Treas. and Purchaser.
W. W. CARD, Secretary.	H. H. WESTINGHOUSE, General Agent.
S. H. SPRAGUE, Assistant Secretary.	T. W. WELSH, Superintendent.

THE WESTINGHOUSE BRAKE CO. LIMITED.

Canal Road, King's Cross,
LONDON.

60 and 62 Rue de la Victoire,
PARIS.



PITTSBURGH, PENNA.

1886.

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PREFACE.

The present edition of our reference book illustrates our automatic brake as applied to both passenger and freight rolling stock, and our train signaling apparatus.

The prices for complete sets are given in the agreements, which will be found on pages 15 to 23, according to the terms of which all our fixtures are sold, and also on page 14.

The automatic brake is now in use on all the prominent lines in this country, and its merits are too well known to need any explanation. An experience of over two years on a number of prominent lines, several of which are entirely equipped, with the automatic brake as applied to freight trains, has demonstrated that its advantages are as great as in passenger service, while the price is so low that the apparatus will speedily be paid for by the saving in flattened wheels and brakemen's wages, to say nothing of the freedom from accidents and the increased service which can be had from a given amount of rolling stock, on account of the higher speed practicable with greater safety.

A list of the patents owned or controlled by this company, and useful information in regard to the maintenance and use of the apparatus, will be found in the Appendix.

1917-
A.P.
Jan 3

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THE WESTINGHOUSE

AUTOMATIC BRAKE.

WE confine ourselves in the descriptive matter of the present work to our automatic brake, the principle of which is illustrated by the drawing shown on Plate B1. The application of this apparatus to an engine is shown on Plate B2, and the application to a car on Plate B3.

The Westinghouse Automatic Brake consists of the following essential parts :

1st. *The Steam Engine and Pump*, which produce the compressed air, the supply of steam being regulated by the pump governor.

2d. *The Main Reservoir*, in which the compressed air is stored.

3d. *The Engineer's Brake-Valve*, which regulates the flow of air from the main reservoir into the brake-pipe for releasing the brakes, and from the brake-pipe to the atmosphere for applying the brakes.

4th. *The Main Brake-Pipe*, which leads from the main reservoir to the engineer's brake-valve, and thence along the train, supplying the apparatus on each vehicle with air.

5th. *The Auxiliary Reservoir*, which takes a supply of air from the main reservoir, through the brake-pipe, and stores it for use on its own vehicle.

6th. *The Brake Cylinder*, which has its piston-rod attached to the brake-levers in such a manner that, when the piston is forced out by air pressure, the brakes are applied.

7th. *The Triple Valve*, which connects the brake-pipe to the auxiliary reservoir, and connects the latter to the brake-cylinder, and is operated by a sudden variation of pressure in the brake-pipe, (1) so as to admit air

from the auxiliary reservoir to the brake-cylinder, which applies the brakes, at the same time cutting off the communication from the brake-pipe to the auxiliary reservoir, or (2) to restore the supply from the brake-pipe to the auxiliary reservoir, at the same time letting the air in the brake-cylinder escape, which releases the brakes.

8th. *The Couplings*, which are attached to flexible hose, and connect the brake-pipe of one vehicle to another.

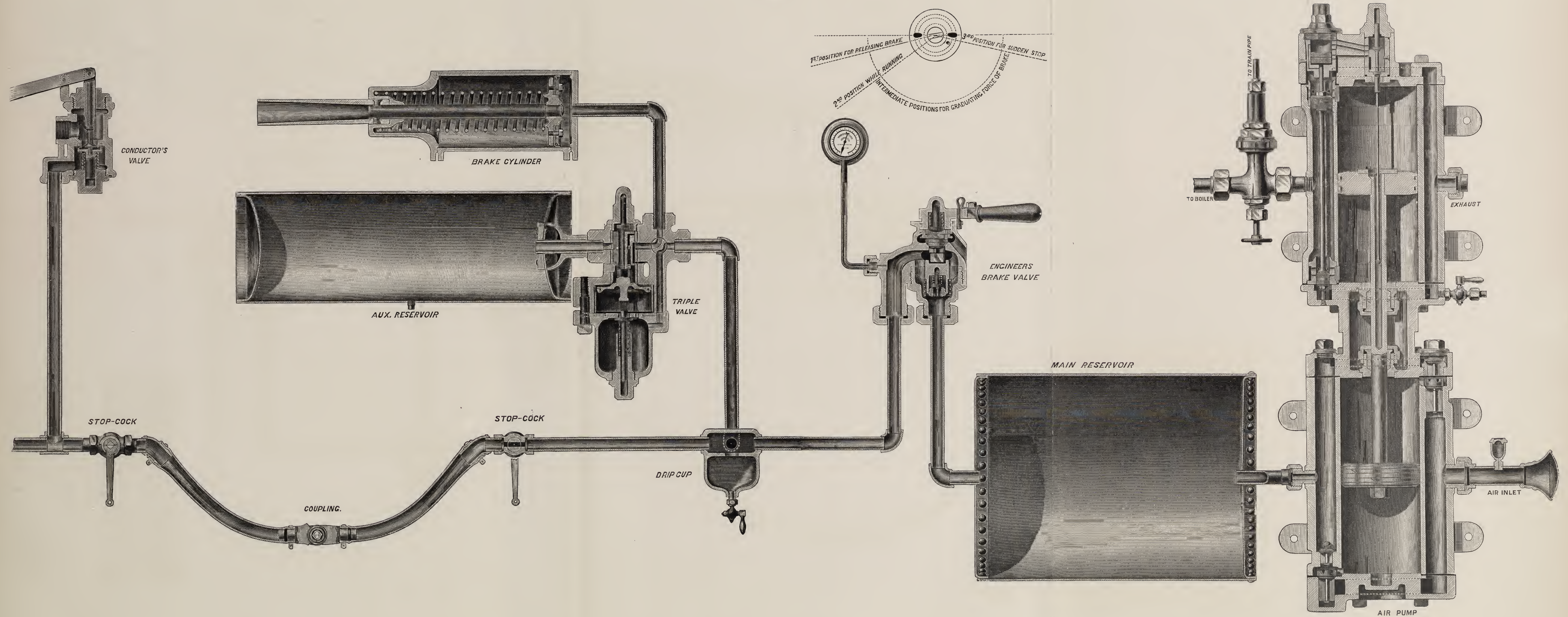
The automatic action of the brake is due to the construction and operation of the triple valve, the primary parts of which are a piston and a slide-valve. A reduction of pressure in the brake-pipe causes the excess of pressure in the auxiliary reservoir to force the piston of the triple valve down, moving the slide-valve so as to allow the air in the auxiliary reservoir to pass directly into the brake-cylinder and apply the brakes. When the pressure in the brake-pipe is again increased above that in the auxiliary reservoir, the piston is forced up, moving the slide-valve to its former position, opening communication from the brake-pipe to the auxiliary reservoir, and permitting the air in the brake-cylinder to escape, thus releasing the brakes.

Thus it will be seen that *any reduction of pressure in the brake-pipe applies the brakes*, which is the essential feature of the automatic brake. If the engineer wishes to apply the brakes, he moves the handle of the engineer's brake-valve to the right, which first closes a valve retaining the pressure in the main reservoir, and then permits a portion of the air in the brake-pipe to escape. To release the brakes, he turns the handle to its former position, which allows the air in the main reservoir to flow into the brake-pipe, restoring the pressure and releasing the brakes. A valve, called the conductor's valve, is placed in each car, with a cord running the length of the car, and any of the train-men, by pulling this cord, can open the valve, which allows the air to escape from the brake-pipe. In applying the brake in this manner the valve must be held open until the train comes to a stop. Should the train break in two, the air in the brake-pipe escapes, and the brakes are applied to both sections of the train; and should a hose or pipe burst, the brakes are also automatically applied.

The gauge shows the pressure in the main reservoir and brake-pipe when they are connected, and the pressure in the brake-pipe alone when the main reservoir is shut off by the movement of the engineer's brake-valve.

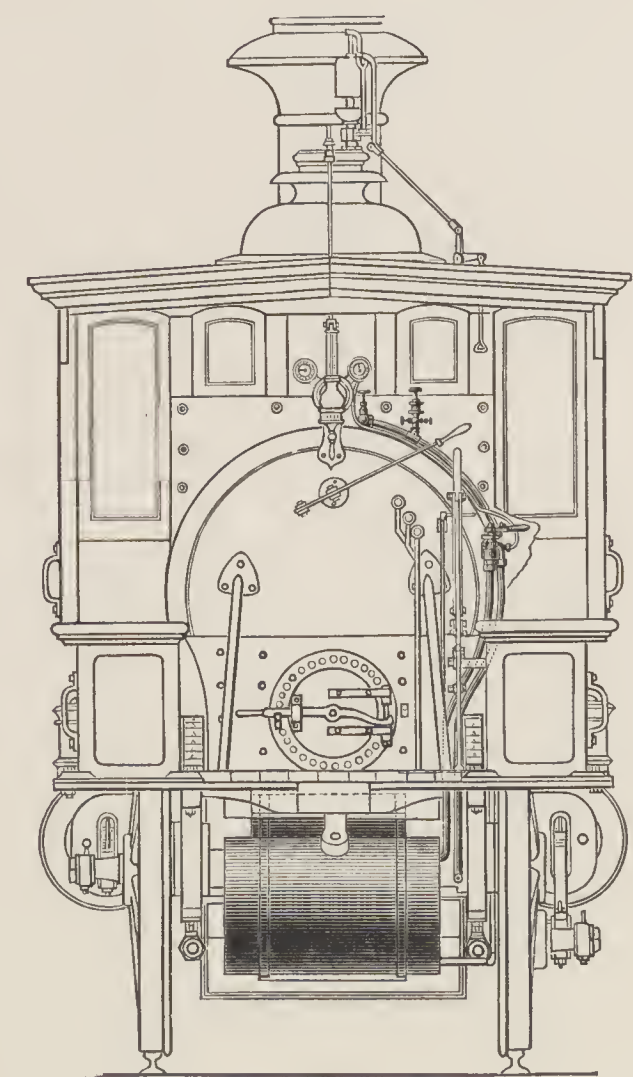
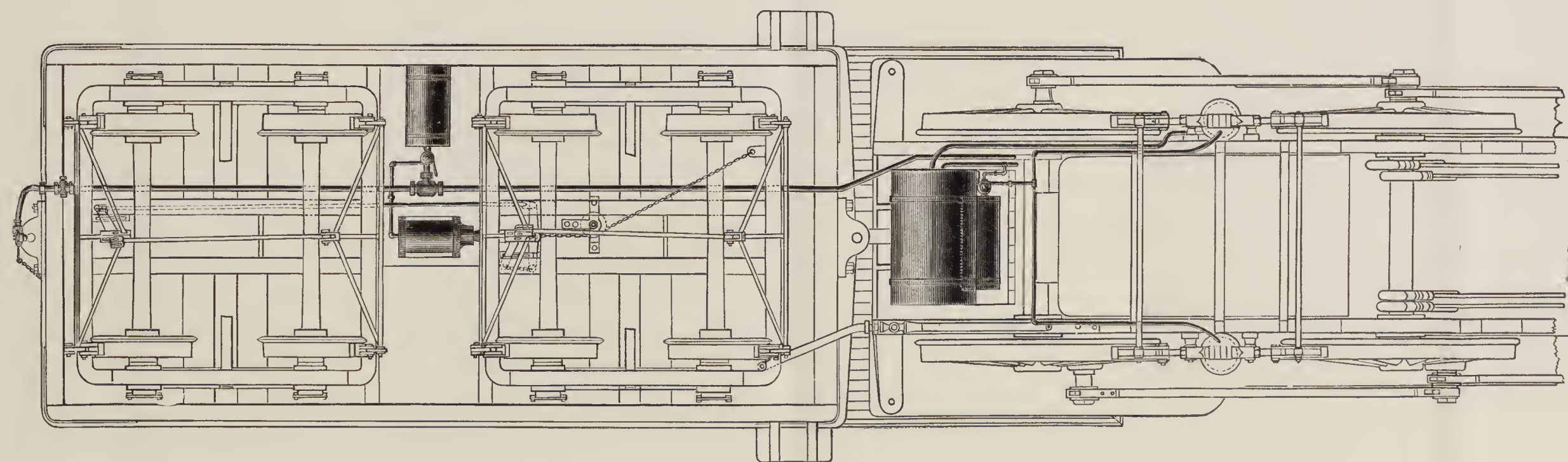
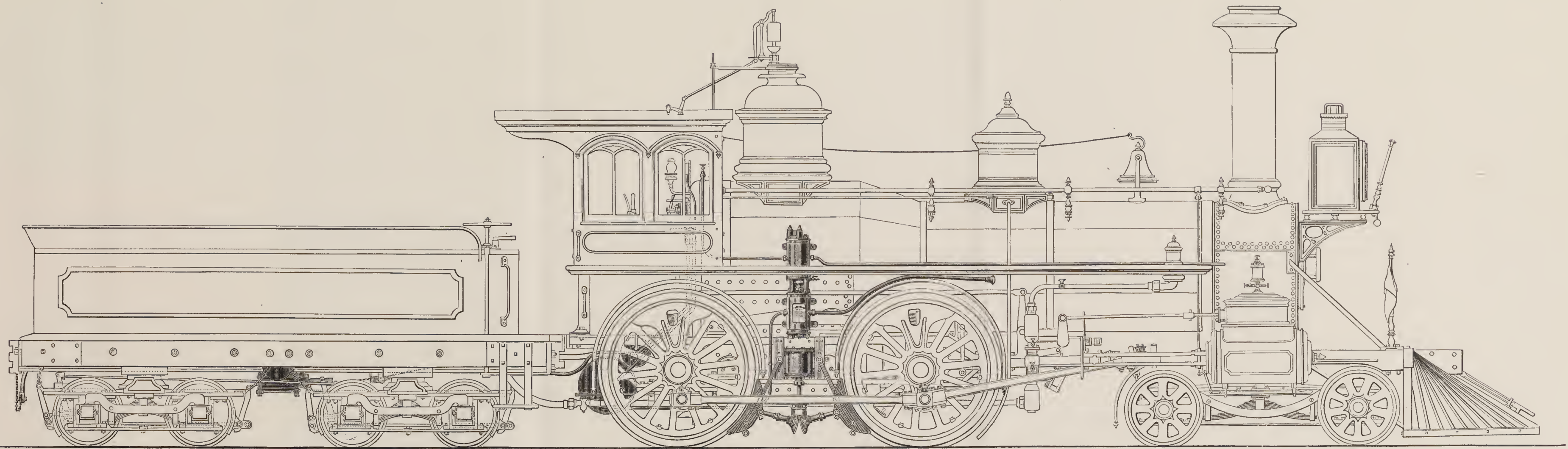
THE AUTOMATIC BRAKE.

PLATE B1.



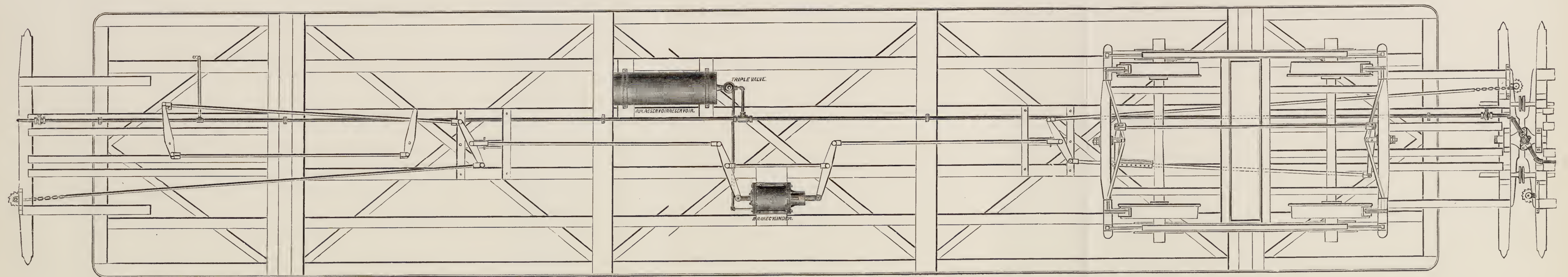
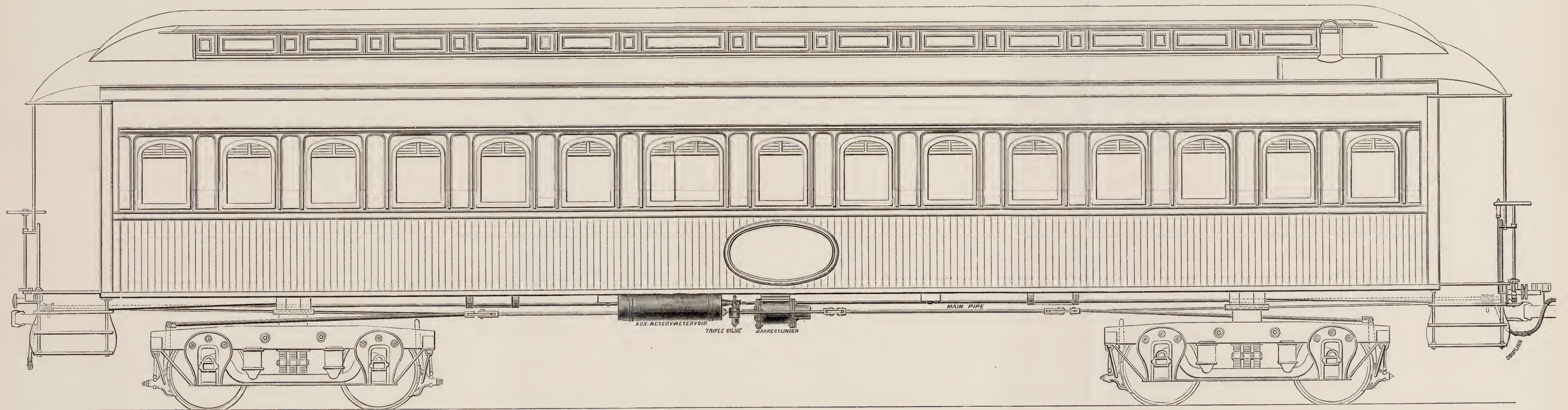
THE AUTOMATIC BRAKE APPLIED TO AN ENGINE.

PLATE B2.



THE AUTOMATIC BRAKE APPLIED TO A CAR.

PLATE B₃.



A *stop cock* is placed in each end of the brake-pipe, and is closed before separating the couplings, thus preventing an application of the brakes when cars are uncoupled.

The diagram above the engineer's brake-valve shows the various positions of the handle for applying the brakes with any desired degree of force, for releasing the brakes, and the position in which the handle is to be kept after the brakes have been released.



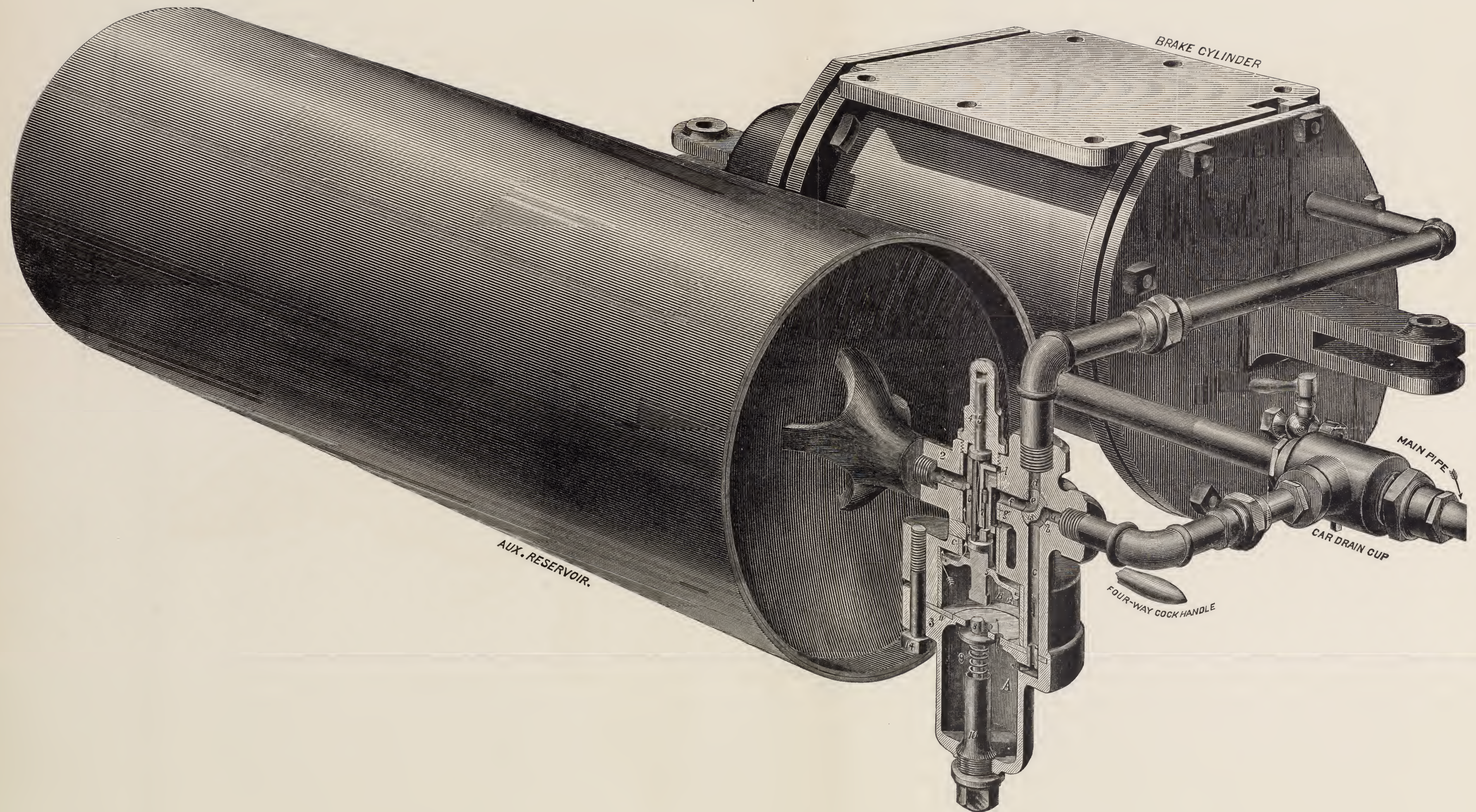
TRIPLE VALVE, RESERVOIR, AND CYLINDER.

PLATE B₄ shows the arrangement of the triple valve, reservoir, and brake-cylinder, from which the operation of the former will be more clearly understood than from a section of the triple valve alone.

The triple valve has a piston, 5, working in the chamber B, and carrying with it a slide-valve, 6. Air enters from the main pipe through the four-way cock 13 into the drain-cup A, and passes to the chamber B, forcing the piston up, and uncovering a small feeding-groove in the upper part of the chamber, which permits air to flow past the piston into the auxiliary reservoir, while, at the same time, there is an open communication from the brake-cylinder to the atmosphere, through the passages *d*, *e*, *f*, and *g*. Air will continue to flow into the auxiliary reservoir until it contains the same pressure as the main brake-pipe.

To apply the brakes with their full force, the compressed air in the main brake-pipe is allowed to escape, when the greater pressure in the auxiliary reservoir forces the piston 5 down, below the feeding-groove, thus preventing the return of air from the reservoir to the brake-pipe. As the piston descends, it moves with it the slide-valve 6, so as to permit air to flow directly from the auxiliary reservoir into the brake-cylinder, which forces the pistons out and applies the brakes. The brakes are released by again admitting pressure into the main brake-pipe from the main reservoir, which pressure, being greater than that in the auxiliary reservoir, forces the piston 5 back to the position shown in the drawing, recharges the reservoir, and at the same time permits the air in the brake-cylinders to escape. To apply the brakes gently, a slight reduction is made in the pressure in the main brake-pipe, which moves the piston down slowly until it is stopped by the graduating spring 9; at this point the opening *l* in the slide-valve is opposite the port *f*, and allows air from the auxiliary reservoir to feed through a hole in the side of the slide-valve and through the opening *l* into the brake-cylinder. The passage *l* is opened and closed by a small valve, 7, which is attached

TRIPLE VALVE, RESERVOIR, AND CYLINDER.
PLATE B4.



to and moves with the piston 5, provision being made for a limited motion of these parts without moving the valve 6. When the pressure in the auxiliary reservoir has been reduced, by expansion into the brake-cylinder, until it is the same as the pressure in the main brake-pipe, the graduating spring pushes the piston up until the small valve, 7, closes the feed opening, *L*. This causes whatever pressure is in the brake-cylinder to be retained, applying the brakes with a force proportionate to the reduction of pressure in the brake-pipe.

To prevent the application of the brakes from a slight reduction of pressure, caused by leakage in the brake-pipe, an oval groove is cut in the body of the car-cylinder, nine sixty-fourths of an inch in width and five sixty-fourths of an inch in depth, and of such a length that the piston must travel three inches before the groove is covered by the packing-leather. A small quantity of air, such as results from a leak, passing from the triple valve into the car-cylinder, has the effect of moving the piston slightly forward, but not sufficiently to close the groove, which permits the air to flow out past the piston. If, however, the brakes are applied in the usual manner, the piston will be moved forward, notwithstanding the slight leak, and will cover the groove. It is very important that the groove shall be of the dimensions given above.

When the handle of the four-way cock, 13, is turned down, there is a direct communication from the main brake-pipe to the brake-cylinder, the triple valve and auxiliary reservoir being cut out, and the apparatus can then be worked as a non-automatic brake by admitting the air into the main brake-pipe and brake-cylinder to apply the brakes. When, from any cause, it is desirable to have the brake inoperative on any particular car, the four-way cock is turned to an intermediate position, which shuts off the brake-cylinder and reservoir, leaving the main brake-pipe unobstructed to supply air to the remaining vehicles.

The release cock can be opened to release the brake on a car which is detached from the locomotive.

The drain-cup, which has a perforated metallic lining of the same diameter as the pipe itself, prevents any sand, scale, or other material that may find its way into the pipe, from passing into the triple valve. It also collects any moisture that may accumulate, and is drained by unscrewing the bottom plug.

Plate B5 shows the various parts used to form complete sets of brake apparatus for either the automatic or the non-automatic system, a number of these parts being illustrated in detail in subsequent sheets. This company furnishes all brake apparatus in accordance with the terms and prices stated in the form of agreement printed herewith, and this plate shows all the articles enumerated in the various schedules of the agreement, as well as a few special parts used in exceptional cases.

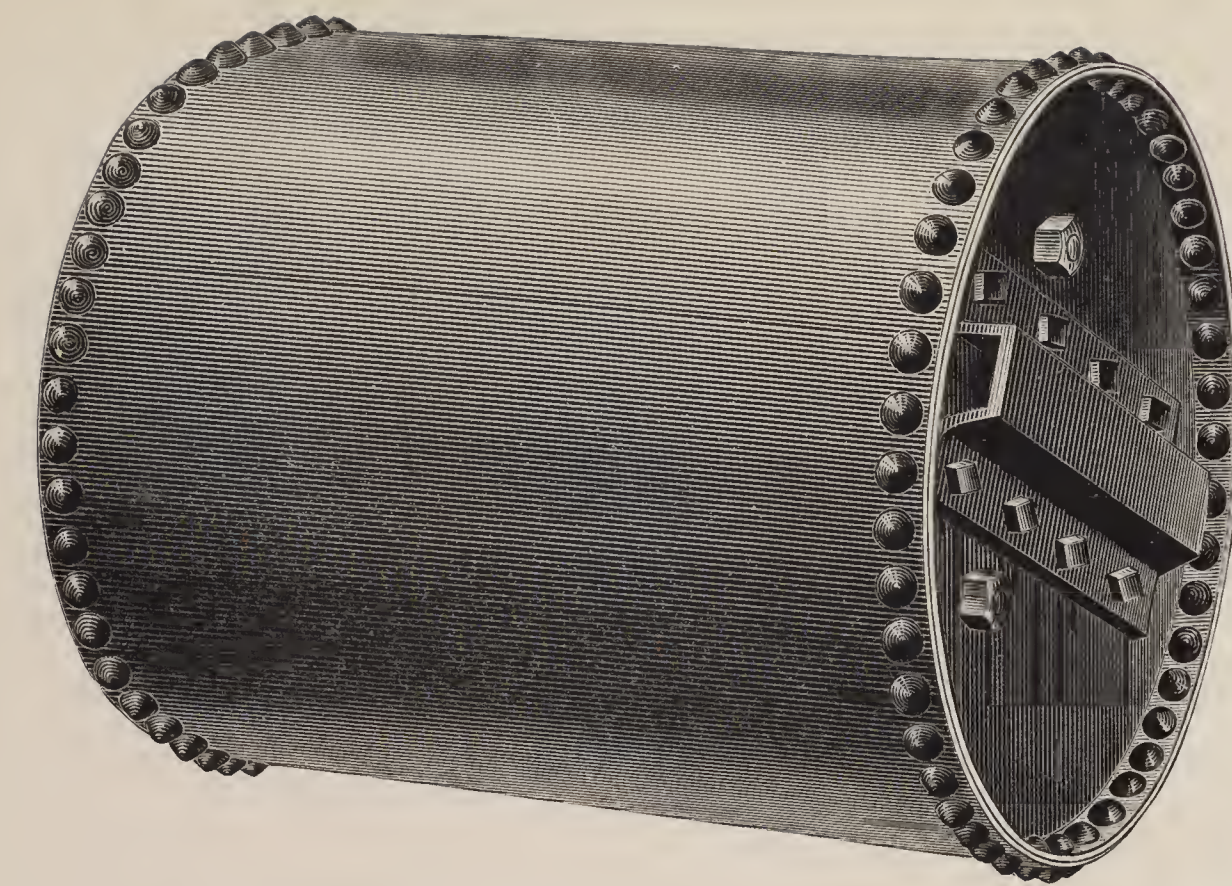
DETAILS OF BRAKE APPARATUS.

PLATE B5.

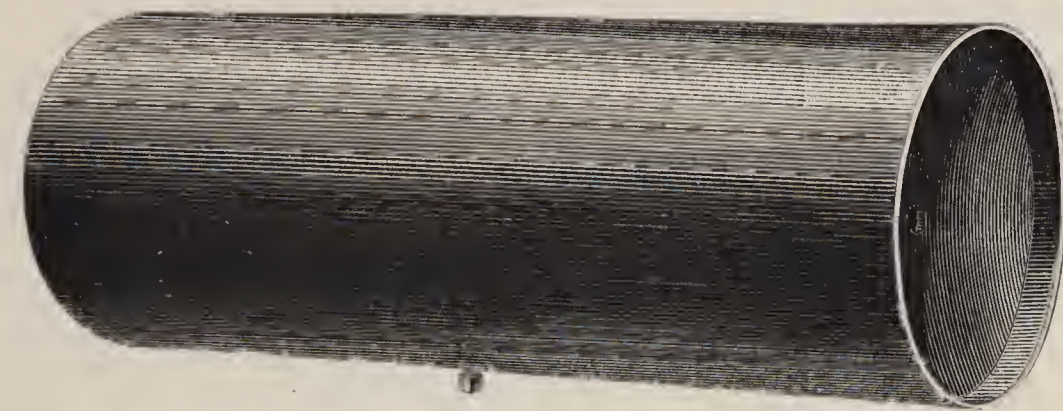
No.	No.
1. Main Reservoir.	21. Conductor's Valve.
2. Auxiliary Reservoir (12 by 33 in.)	22. Triple Valve.
3. Auxiliary Reservoir (10 by 24 in.)	23. Triple Valve, with Brass Case.
4. Standard Air-pump.	24. Cylinder Release Cock.
5. Eight-inch Air-pump.	25. Air-pipe Strainer.
6. Narrow-gauge Air-pump.	26. Tender Drain-cup.
7. Narrow-gauge Car-cylinder.	27. Car Drain-cup.
8. Tender Cylinder.	28. Triple Valve Bracket.
9. Standard Car-cylinder.	28a. Triple Valve Nipple.
10. Standard Driving-wheel Brake-cylinder.	29. Double Check-valve.
11. Narrow-gauge Driving-wheel Brake-cylinder.	30. Three-quarter-inch Reservoir Union.
12. Engineer's Brake-valve.	31. One-inch Reservoir Union.
13. Three-way Cock.	32. Discharge-valve Seat Wrench.
14. Air-gauge.	33. Auxiliary Brake-valve.
15. Automatic Lubricator.	34. One-inch Malleable Union.
16. Three-quarter-inch Stop-cock.	35. Three-quarter-inch Malleable Union.
17. Pump Regulator.	36. One-half-inch Malleable Union.
18. Steam Valve.	37. One-quarter-inch Malleable Union.
19. Pump Drain-cock.	38. Three-quarter-inch by one-half-inch T.
20. Air-cylinder Oil-cup.	

BRAKE APPARATUS.

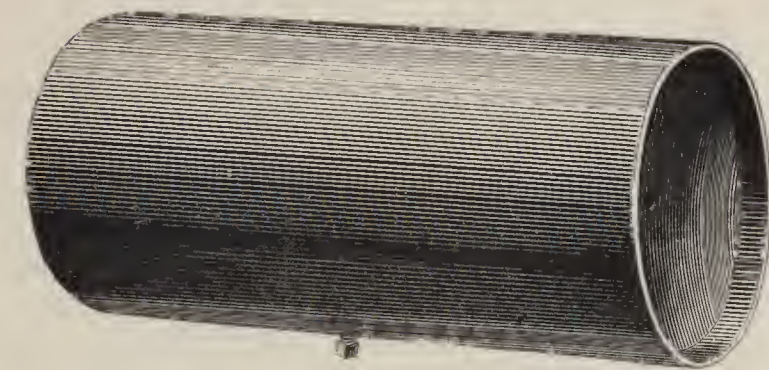
PLATE B5.



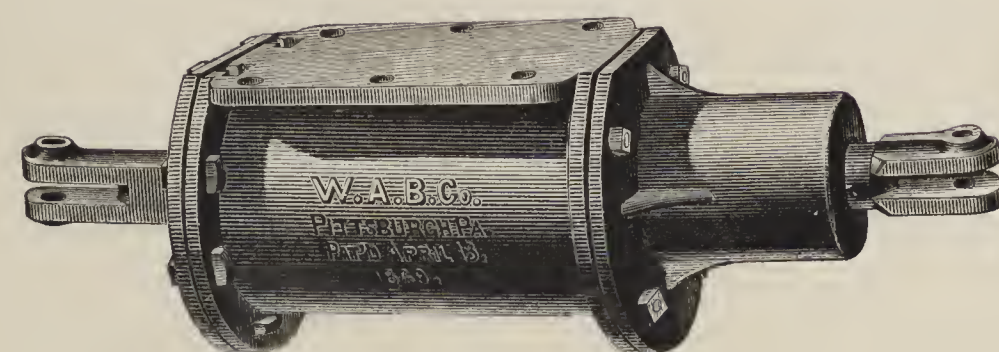
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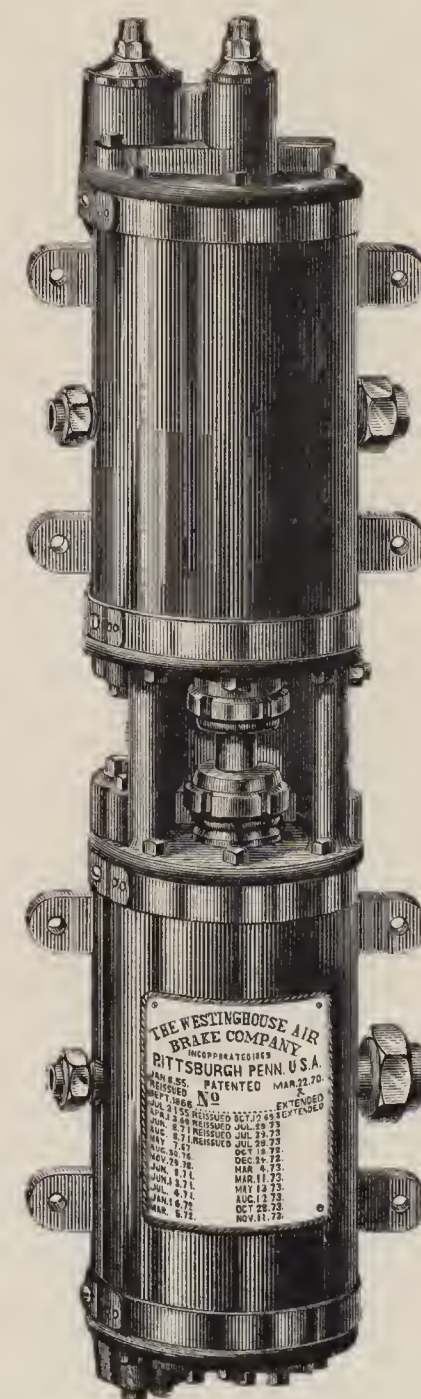
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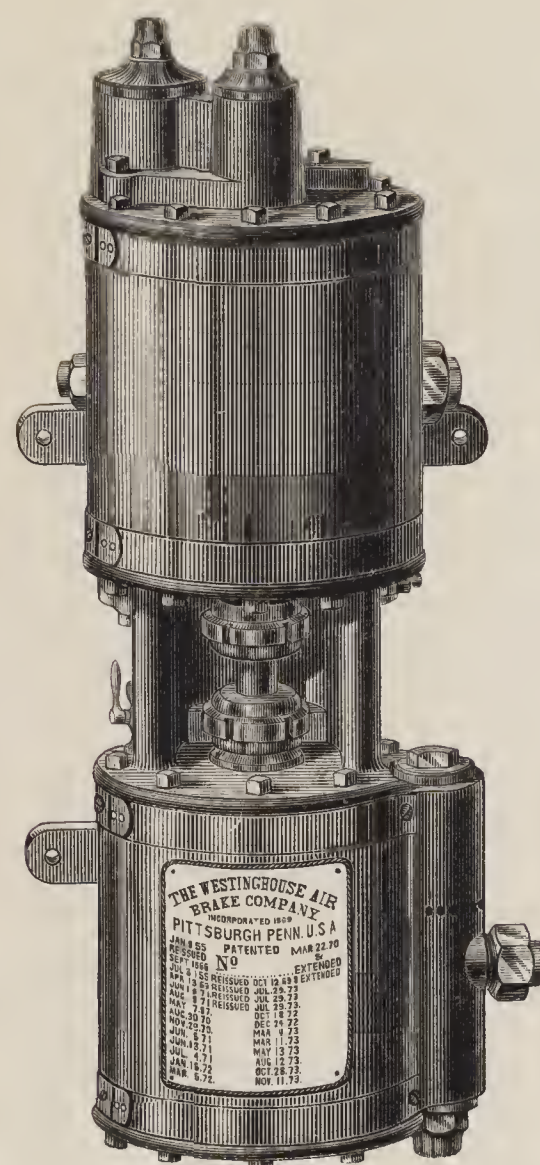
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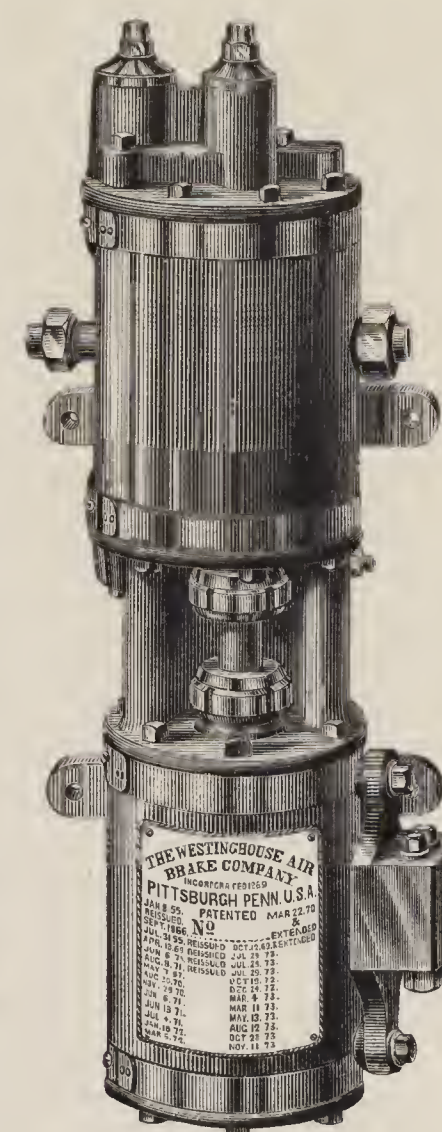
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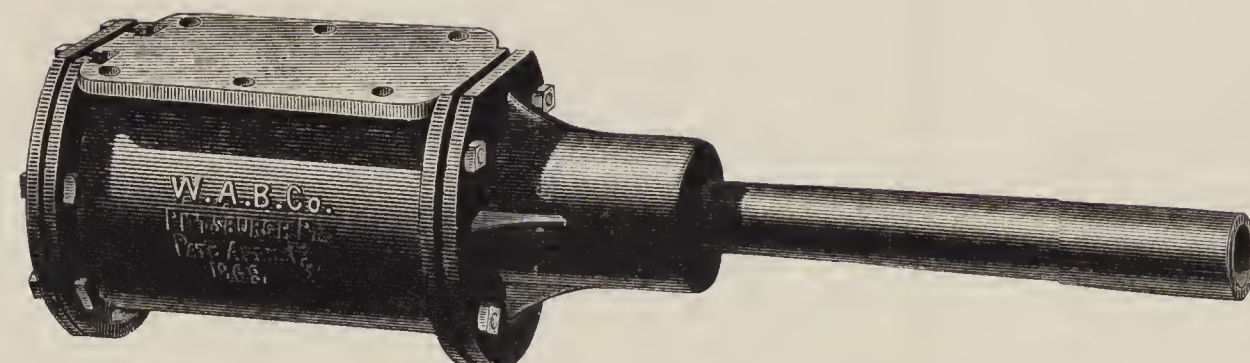
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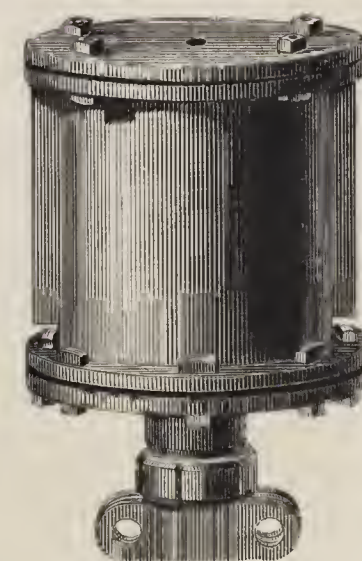
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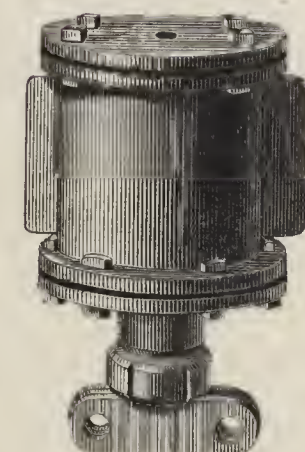
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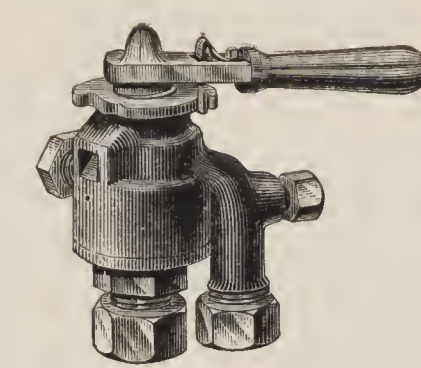
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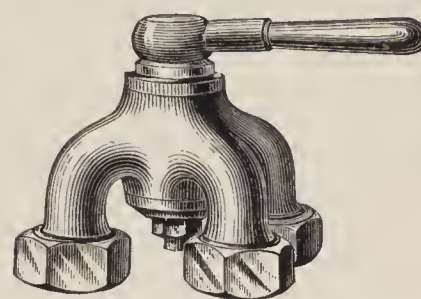
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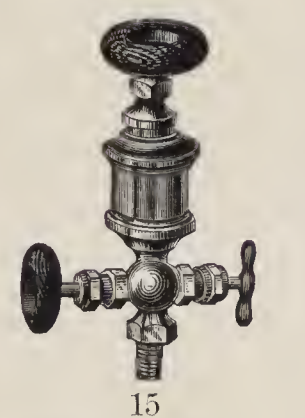
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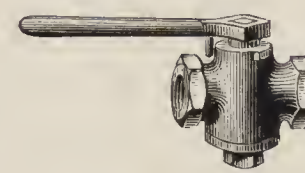
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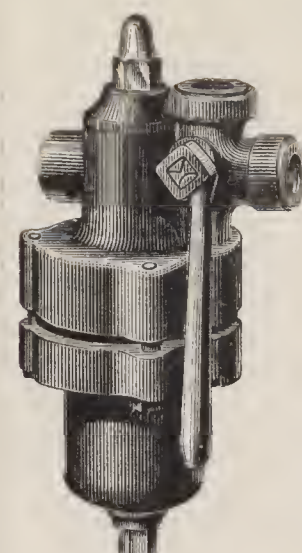
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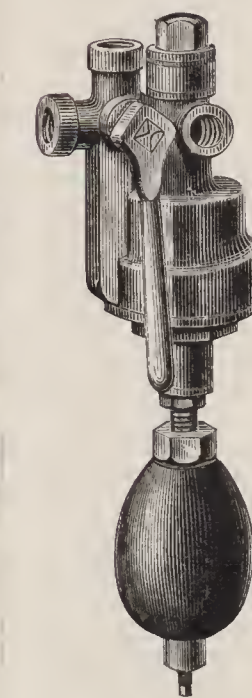
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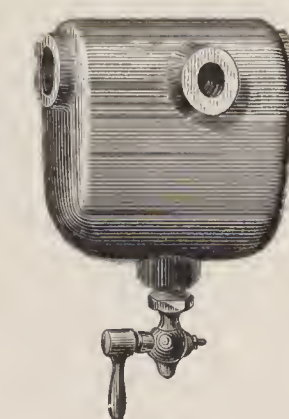
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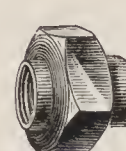
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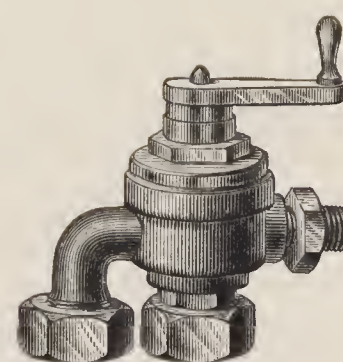
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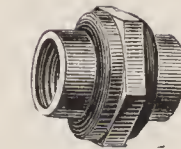
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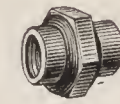
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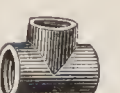
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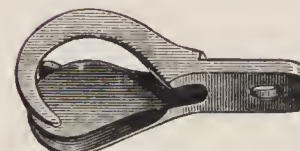
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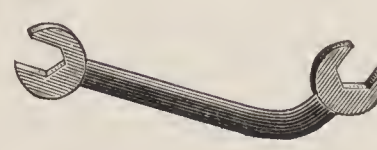
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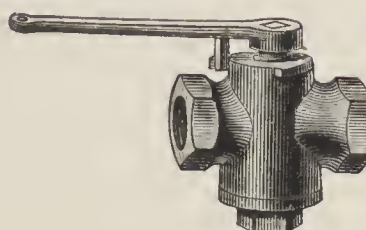
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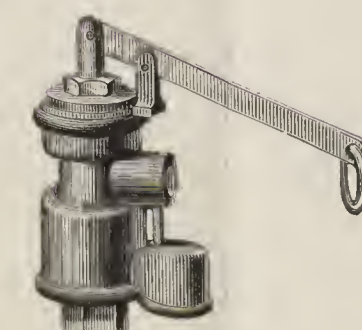
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58



21

DETAILS OF BRAKE APPARATUS — CONTINUED.

PLATE B5.

No.	No.
39. One-half-inch T.	50. Packing-nut Wrench.
40. One-half-inch by three-eighth-inch T.	51. Hose and Coupling, Narrow-gauge.
41. Half-inch by quarter-inch T.	52. Hose and Coupling Standard for three-quarter-inch Pipe.
42. One-inch L.	53. Hose and Coupling for one-inch Pipe.
43. Three-quarter-inch L.	54. Hose and Coupling for Signaling.
44. One-half-inch L.	55. Driving-wheel Brake Hose.
45. One-quarter-inch L.	56. Standard Hose.
46. One-half-inch Nipple.	57. Narrow-gauge Hose.
47. Three-quarter-inch Nipple.	58. One-inch Stop Cock.
48. Coupling Hook.	
49. Cap-screw Wrench.	

SCHEDULE OF PRICES FOR COMPLETE SETS.

NON-AUTOMATIC BRAKE.

One Set Locomotive Fixtures (Schedule A, including cylinders for driving-wheel brakes if desired)	\$300.00
One Set Tender Fixtures (Schedule B)	25.00
One Set Car Fixtures (Schedule C)	100.00

AUTOMATIC BRAKE.

One Set Locomotive Fixtures (Schedule E, including cylinders for driving-wheel brakes if desired)	300.00
One Set Tender Fixtures (Schedule F)	60.00
One Set Car Fixtures (Schedule G)	138.00

FREIGHT BRAKE.

One Set Freight Car Fixtures (Schedule H)	50.00
---	-------

DRIVING-WHEEL BRAKES.

One Set Castings and Forgings for Driving-wheel Brakes (except in special cases), Cylinders furnished with Locomotive Fixtures without extra charge	125.00
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AGREEMENT.

WHEREAS, THE WESTINGHOUSE AIR-BRAKE COMPANY of the City of Pittsburgh, Pennsylvania, operating under sundry Letters Patent of the United States, some of which are owned or controlled by the said Company, and others of which are owned by George Westinghouse, Jr., of said city, as patentee, is engaged in making and selling apparatus for operating railway car brakes by compressed air, which apparatus, as adapted for use on the different parts of a railway train, or as employed on trains in different modes of operation, is for convenience classified as per the following schedules :

Schedule A (constituting the equipment of a locomotive in the system of brake apparatus heretofore in use as the Westinghouse Air-Brake): One Steam Engine and Pump, One Main Air Reservoir, One Air-gauge, One Three-way Cock, One one-and-three-quarter-inch Lubricator, One Oil-cup for Air-pump, One Steam-cock, One Drain-cock, One Safety-valve, One Air-pipe Strainer, Hose and Couplings with Valves, One three-foot Hose Connection, one hundred and twenty-five feet of Pipe, assorted sizes, Thirty Pipe Fittings, assorted, Three Wrenches.

Schedule B (constituting the equipment of a tender in the same system): One eight-inch Air-brake Cylinder complete, with sleeve.

Schedule C (constituting the equipment of a passenger car in the same system): One ten-inch Air-brake Cylinder complete, with Releasing Springs, Hose and Couplings with Valves complete, one hundred and thirty feet of Pipe, assorted sizes, Thirteen Pipe Fittings, assorted.

Schedule D (being the additional apparatus provided for equipping a locomotive-driver brake in the same or AUTOMATIC system): Two eight-inch Air-brake Cylinders, Thirty feet half-inch Pipe, Six Pipe Fittings, assorted, One Check-valve, One Safety-valve.

Schedule E (constituting the equipment of a locomotive in the Westinghouse AUTOMATIC system): Same as "Schedule A," for "Hose and Couplings *with* Valves," substituting "Hose and Couplings *without* Valves," and one Stop-cock.

Schedule F (constituting the equipment for a tender in the AUTOMATIC system): One eight-inch Air-brake Cylinder complete, with Releasing Cock, One Triple Valve, with Nipple and Bracket, One Auxiliary Air Reservoir, One Drain Cup and Cock, ten feet half-inch Pipe, Six Pipe Fittings, assorted.

Schedule G (constituting the equipment for a passenger car in the AUTOMATIC system): One ten-inch Cylinder, as in "Schedule C," with Releasing Cock, One Auxiliary Air Reservoir, One Drain Cup, One Triple Valve, with Nipple and Bracket, One Conductor's Valve, Hose and Couplings without Valves, Two Stop-cocks, seventy-five feet Pipe, Twelve Pipe Fittings, assorted.

Schedule V (being the apparatus provided as additional to that mentioned in "Schedules A and B," for equipping a locomotive and tender to work both the "old" and "automatic" systems): One Auxiliary Air Reservoir, One Triple Valve, Hose and Couplings, ten feet half-inch Pipe, thirty feet three-quarter-inch Pipe, Five Pipe Fittings, assorted.

Schedule W (being the apparatus provided as additional to that mentioned in "Schedule C," for a passenger train under both the "old" and "automatic" systems): One Auxiliary Air Reservoir, One Triple Valve, One Conductor's Valve, One Double Check-valve, One Drain Cup, Hose and Couplings without Valves, eighty feet of Pipe, assorted sizes, Twelve Pipe Fittings, assorted.

Schedule X (being apparatus required to change a passenger car from the "old" to the "automatic" system): One Auxiliary Air Reservoir with Drain Cock, One Triple Valve, One Conductor's Valve, One Drain Cup, Hose and Couplings. (Pipe of old brake can be utilized.)

Schedule Y (constituting a brake equipment complete for a locomotive and tender in the "old" system): The Articles named in Schedules A, B, and D, when ordered together.

Schedule Z (constituting a brake equipment complete for a locomotive and tender in the AUTOMATIC system): The articles named in Schedules E, F, and D, when ordered together.

And whereas, The.....Company,
a Corporation duly authorized under the laws of the State of.....
.....and operating what is known as
the.....
is desirous of introducing some or all of the apparatus named in said schedules
into use on its said road.

Now these presents witness, That the said "WESTINGHOUSE AIR-BRAKE
COMPANY," party of the first part hereto, and the said GEORGE WESTING-
HOUSE, Jr., party of the second part hereto, and the said.....
.....Company, party of the third part hereto, for the
considerations hereinafter named, have covenanted and agreed, and do hereby
covenant and agree, to and with each other, as follows, to wit:

1st. That the said party of the first part will, within a reasonable time
after the proper order or orders therefor are received, sell and deliver, well
made and in good order and condition, to said party of the third part, such
sets and such number of sets of the said apparatus (the articles designated
in any one of the foregoing schedules constituting a set) as may be ordered
from time to time, at a rate not to exceed for each schedule set the prices
to such schedules herewith respectively annexed, as follows:

Schedule A.—Three Hundred Dollars.

" *B.*—Twenty-five Dollars.

" *C.*—One Hundred Dollars.

" *D.*—Fifty Dollars.

" *E.*—Three Hundred Dollars.

" *F.*—Sixty Dollars.

" *G.*—One Hundred and Thirty-
eight Dollars.

Schedule V.—Thirty-five Dollars.

" *W.*—Eighty-eight Dollars.

" *X.*—Eighty Dollars.

" *Y.*—Three Hundred and
Twenty-five Dollars.

" *Z.*—Three Hundred and Sixty
Dollars.

Which prices are for sets so purchased, and when paid for, inclusive of
license fee or royalty for the use thereof, complete and unbroken, on the
locomotive, tender, or car to which they may be applied; but the license to
use shall not be complete and effectual to protect the purchaser or other
subsequent possessor of such apparatus in the use thereof until the said
prices are fully paid. The said schedules shall be subject to change or
variation as, and only as, the articles designated therein may by further
improvement be rendered practically useless, or as, by further improvement,

other devices of like function may be provided as substitutes for those named, but such changes or variations shall not cause any change in the prices of the schedule sets, as above given.

Delivery in all cases to be made at the depot, wharf, or other designated place of shipment or consignment in the city of Pittsburgh.

2d. That the said party of the first part, within like reasonable time, will sell, and in like manner deliver, to said party of the third part, such parts or pieces, or separate detached portions of the apparatus named in the foregoing schedules, as may be required for renewals and ordinary repairs in previously purchased complete sets of the said apparatus, charging therefor the reasonable manufacturers' price for making the same, and without other or additional license fee or royalty.

3d. That the said party of the third part shall make and keep a correct record, open at all reasonable times to the inspection of said party of the first part, or its duly authorized officer or agent, of all cars, locomotives, and tenders owned or leased by it and equipped with air-brake apparatus; which record shall contain and show all additions to the said equipment, by new sets applied, or by the purchase or lease of rolling stock already so equipped, and from whom purchased or leased, as also the reductions of such equipment by sale or lease of rolling stock ready equipped, and to whom sold or leased; but the said party of the third part shall not order, for the purpose of selling, leasing, or otherwise disposing of, to others, any part or parts of sets, nor a whole set, except in connection with the car, tender, or locomotive to which it may be applied, nor shall it use any part or parts of sets otherwise than in renewing or repairing the lost, broken, or worn-out parts of complete sets previously bought and paid for.

4th. That in case the said party of the first part should at any time hereafter become possessed of, own, or control any other patent or patents for further IMPROVEMENTS in the construction of the devices named in said schedules, which improvements the said party of the third part may be desirous of using, the said party of the first part shall sell and deliver to said party of the third part, in like manner, for like use and subject to like conditions, as aforesaid, on proper orders received, the devices so improved, at the reasonable manufacturers' price for making the same, without other or additional license fee or royalty except such as will reasonably remunerate the said party of the first part for actual outlay in the purchase of the patents for said improvements.

5th. That on the delivery as aforesaid of any of the apparatus hereinbefore referred to, the said party of the third part will pay to said party of the first part the price thereof, as fixed or stipulated to be fixed by the foregoing provisions.

6th. That the said party of the first part, in order to secure and preserve complete uniformity in all parts of the said apparatus as used on different, though connecting, railway lines, hereby expressly reserves to itself a right, exercisable at its own option, to furnish to said party of the third part ready for use, but free of cost, any or all parts of said apparatus of substantially the same construction as that previously furnished, and differing only in form or dimensions, which apparatus, so furnished, the said party of the third part, in furtherance of the same object, shall and does hereby agree thereafter to apply and use, to the exclusion of the like devices for which they may be designed as a substitute; and for the same purpose, the said party of the first part also reserves the right to make and furnish, at reasonable manufacturers' price, and deliverable in the manner aforesaid, all Couplings, Leakage Valves, Double Check-valves and Triple Valves, and each and every part thereof with which the said party of the third part may desire to renew or replace the corresponding devices or parts on the same car, tender, or locomotive, worn out, broken, or lost.

7th. In case the said party of the first part should at any time grant any reduction in prices above named, or any right or license to any railway company or corporation to manufacture and sell, for railway car-brake purposes, any or all the patented improvements named in said schedules, then the said party of the third part shall be entitled to a like reduction for a like consideration, and a like right and license on like terms, considerations, and conditions; but nothing herein contained shall be so construed as to prevent the said party of the third part from making all necessary repairs to the apparatus purchased by the said party of the first part as hereinbefore provided, or of any part thereof, except as mentioned in paragraph 6th, above.

8th. That the said party of the first part will indemnify and save harmless the said party of the third part from all necessary or proper costs, expense, or damages incurred by reason of any suit or suits against the said party of the third part for any alleged infringement of any other letters patent, which alleged infringement shall consist in the use of the apparatus, furnished to said party of the third part under the foregoing provisions, provided that the said party of the first part shall first have written notice of such suit or suits, and be allowed the opportunity of defending the same.

9th. That the said party of the third part shall have the right to run locomotives, tenders, and cars, fitted up with air-brake apparatus purchased from the said party of the first part as hereinbefore provided, over or on any connecting line of railway, or any railway line owned, leased, or controlled by them, without the payment of other or additional consideration therefor; provided, however, that nothing herein contained shall be construed as authorizing the use of any of the apparatus named in the above schedules in combination with steam or air brake apparatus not made by or under license from the parties of the first and second parts.

To a due and faithful compliance with the covenants and agreements hereinbefore contained, the said parties of the first, second, and third parts do hereby bind themselves, their legal representatives, successors, and assigns, each to the other, and his or their legal representatives, successors, and assigns.

In *witness whereof*, The said parties of the first and third parts have caused their corporate seals to be hereunto affixed, attested by the hands of the Presidents and Secretaries of the said respective Corporations, and the said party of the second part has hereunto set his hand and seal, this.....day of.....A. D. 188

.....
[L. S.]

.....
President Westinghouse Air-Brake Company.

Attest:

.....
Secretary Westinghouse Air-Brake Company.

.....
President.....Company.

Attest:

.....
Secretary.....Company.

SUPPLEMENTARY AGREEMENT.

Whereas, THE WESTINGHOUSE AIR-BRAKE CO., of Allegheny County, Pennsylvania, under an agreement bearing date.....
(to which this agreement is a supplement), has been furnishing to the Railway Company hereinafter named, and designated as the party of the third part, certain Air-Brake Apparatus, for the equipment of the passenger rolling stock of said Company :

And whereas, The said The Westinghouse Air-Brake Company, licensee under sundry patents of the United States, owned by George Westinghouse, Jr., patentee, has recently perfected and is now introducing a system of Air-Brake Apparatus designed for use on freight cars, which said apparatus the said Railway Company, party of the third part hereto, is desirous of purchasing and using :

Now these presents witness, That the said The Westinghouse Air-Brake Company, party of the first part hereto, the said George Westinghouse, Jr., party of the second part hereto, and The.....
.....Company, party of the third part hereto, for the consideration hereinafter named, have further covenanted and agreed, and do hereby further covenant and agree, to and with each other, as follows, to wit :

1st. That the said party of the first part will, within a reasonable time after the order or orders therefor are received, sell and deliver, well made and in good order and condition, to said party of the third part, such number of sets of freight car air-brake apparatus as may be ordered from time to time, at a rate not to exceed fifty dollars per set, each such set of apparatus consisting of the parts and of the sizes enumerated in the following :

SCHEDULE H. One Brake Cylinder, not exceeding eight inches in diameter, with twelve inches stroke, One Auxiliary Reservoir, not exceeding eleven by twenty-one and one-half inches, One Triple Valve, One Pressure Retaining Valve, One Car Drain Cup, Two Hose and Couplings, Two Coupling Hooks, Two 1 in. Stop Cocks, The necessary amount of 1 in. Pipe and Fittings ;

which said price for sets so purchased is, when paid, inclusive of license fee or royalty for the use thereof, complete and unbroken, on the freight cars to which they may be applied; but the license to use shall not be complete or effectual to protect the purchaser or other subsequent possessor of such apparatus in the use thereof, until the same has been fully paid for.

Delivery in all cases to be made at the depot, wharf, or other designated place of shipment in the City of Pittsburgh or Allegheny.

In case such sets of apparatus of larger size are required, the extra reasonable manufacturers' price of making the same shall be added to said price of fifty dollars per set.

2d. The said party of the third part is not licensed to use, and shall not use, said freight brake apparatus, nor any brake cylinder, auxiliary reservoir, or triple valve thereof in the equipment of passenger cars, nor of mail, express, or baggage cars, nor of any other cars intended or designated to run regularly in passenger train service or as a part of a passenger train; but the occasional use of a freight car equipped with the apparatus of Schedule H, in passenger train service, in order to meet a special emergency, will not be considered as a violation of this clause of this supplementary agreement.

3d. The apparatus for use on freight locomotives and freight tenders will be furnished under the provisions of said original agreement (to which this is a supplement), and at the rates and subject to the conditions therein named.

4th. That sales to said party of the third part, of separate portions or pieces of the said freight brake apparatus, for use in renewals and repairs, as stated in the second clause of said original agreement (to which this is a supplement), shall be as and at the rates stated in said second clause; that the obligations and restrictions imposed on said party of the third part, by the third clause of said original agreement, shall apply also to said freight brake apparatus, in like manner as to the other sets of air brake equipment therein named; that as regards the said freight brake apparatus, the said party of the third part shall enjoy the benefit of the provisions of the fourth clause of said original agreement; that the provisions of the fifth and sixth clauses of said original agreement are hereby adopted as a part hereof, and made applicable to said freight brake apparatus, in like manner as to the air-brake apparatus therein named or referred to; that in case of any future reduction in the price of said freight brake apparatus, or of the grant of any license to a railway company to manufacture the same, then the said party of the third part shall be entitled to the same benefits in relation thereof as are set forth in the seventh clause of said original agreement; and

that the provisions of the eighth and ninth clauses of said original agreement are here adopted as a part hereof, in their application to freight brake apparatus.

5th. The said party of the first part will, on application therefor, furnish at its own expense, for a reasonable time, competent men to superintend the application of said freight brake apparatus to the freight cars of said party of the third part; to inspect the same from time to time, with reference to keeping it in good condition, and to instruct its engineers in the proper use thereof; provided, however, said party of the third part shall furnish all needful transportation for the men so employed.

To a due and faithful compliance with the covenants and agreements hereinbefore contained, the said parties of the first, second, and third parts do hereby bind themselves, their legal representatives, successors, and assigns, each to the other, and his or their legal representatives, successors, and assigns.

In witness whereof, The said parties of the first and third parts have caused their corporate seals to be hereunto affixed, attested by the hands of the Presidents and Secretaries of the said respective Corporations, and the said party of the second part has hereunto set his hand and seal, thisday of.....A. D. 188

.....[L. S.]

.....
President Westinghouse Air-Brake Company.

Attest :

.....
Secretary Westinghouse Air-Brake Company.

.....
President.....Company.

Attest :

.....
Secretary.....Company.

DETAILS OF STANDARD PUMP.

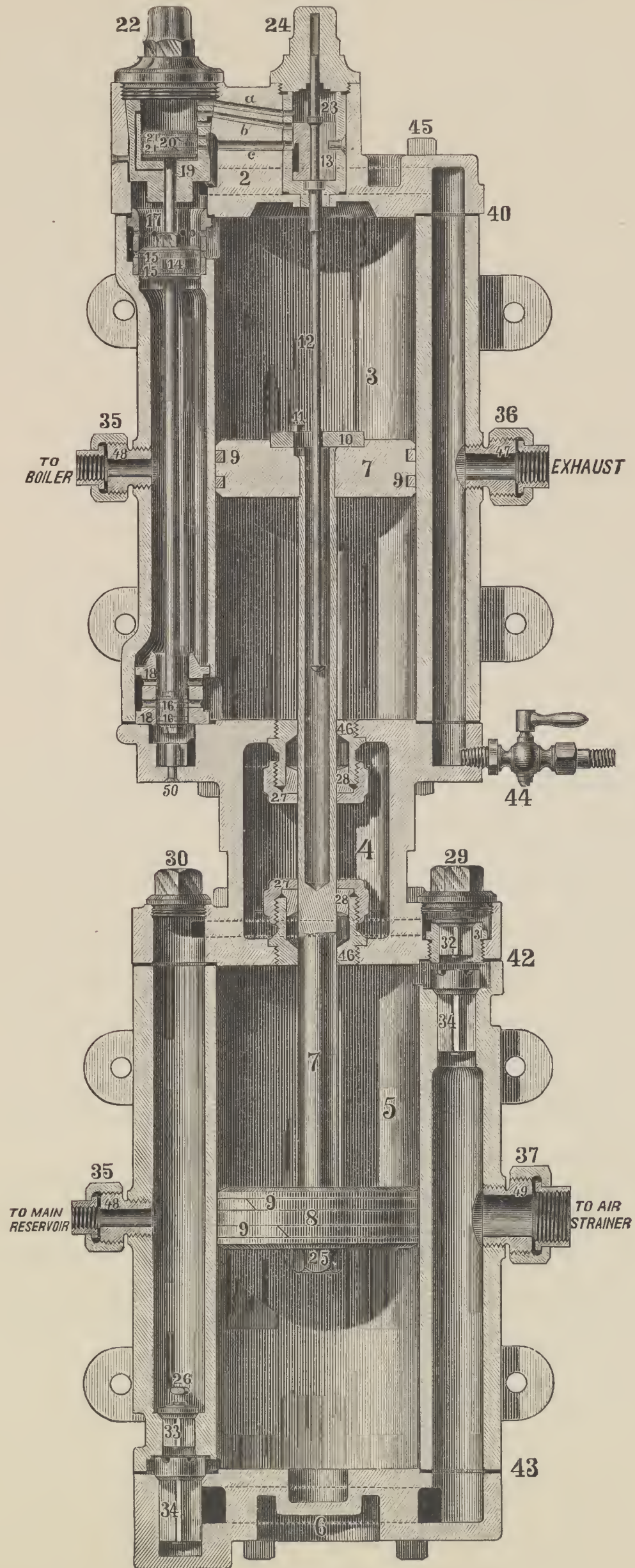
PLATE B 6.

No.	No.
1. Engine and Pump, complete. (No. 4, Plate B5.)	22. Reversing-cylinder cap.
2. Steam-cylinder Head (with Reversing-cylinder, Piston, and Valve Bushes).	23. Reversing-valve Bush.
3. Steam-cylinder (with Main Valve and Bushes).	24. Reversing-valve Cap.
4. Center-piece.	25. Piston-rod Nut.
5. Air-cylinder (with Lower Discharge-valve).	26. Discharge-valve Stop-bolt.
6. Air-cylinder Head.	27. Piston-Packing Nut.
7. Steam-piston and Rod.	28. Piston-packing Gland.
8. Air-piston.	29. Right Chamber Cap.
9. Main Piston Packing-ring.	30. Left Chamber Cap.
10. Reversing-valve Plate.	31. Discharge-valve Seat.
11. Reversing-valve Plate Bolt.	32. Upper Discharge-valve.
12. Reversing-valve Stem.	33. Lower Discharge-valve.
13. Reversing-valve.	34. Receiving-valve.
14. Main Steam-valve.	35. Half-inch Union.
15. Packing-ring for Upper Piston-valve.	36. Three-quarter-inch Union.
16. Packing-ring for Lower Piston-valve.	37. One-inch Union.
17. Upper Main Steam-valve Bush.	40. Top Steam-cylinder Gasket.
18. Lower Main Steam-valve Bush.	41. Bottom Steam-cylinder Gasket.
19. Reversing-cylinder.	42. Top Air-cylinder Gasket.
20. Reversing-piston.	43. Bottom Air-cylinder Gasket.
21. Reversing-piston Packing-ring.	44. Drain Cock.
	45. Cap Screw.
	46. Packing Case.
	47. Exhaust Union Stud.
	48. Steam-pipe Union Stud.
	49. Air-pipe Union Stud.
	50. Main-valve Stop.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

STANDARD AIR-PUMP.

PLATE B 6.



STANDARD AIR-PUMP.

PLATE B6 shows the pump that has been most extensively used in standard gauge equipment, and this style is invariably furnished except when some one of the other designs illustrated herewith is designated.

The steam from the boiler enters the top cylinder between two pistons forming the main valve 14. The upper piston being of greater diameter than the lower, the tendency of the pressure is to raise the valve, unless it is held down by the pressure of a third piston, 20, of still greater diameter, working in a cylinder directly above the main valve.

The pressure on this third piston is regulated by the small slide-valve 13, working in the central chamber on the top head. This valve receives its motion from a rod, 12, extending into the hollow piston, which, as shown in the drawing, has a knob at its lower end and a shoulder just below the top head. This valve chamber in the top head, by a suitable steam-port, is constantly in communication with the steam space between the two pistons of the main valve. The steam acting on the third piston, 20, and holding the main valve down, enters below the main piston; as the main piston approaches the upper head, the reversing-valve rod, 12, and its valve, 13, are raised until the slide-valve exhausts the steam from the space above the third or reversing piston, when the main valve is raised by the steam pressure on the greater area of its upper piston, which movement of the main valve admits steam to the upper end of the main cylinder.

When the main valve is moved up to admit steam to the upper end of the cylinder, it opens an exhaust-port at the lower end, just below the lower steam-port, which latter is closed by the lower piston of the main valve; and when the main piston is on its upward stroke, the upper exhaust-port is similarly opened. The air-valves of the pump are similar to those used in

all pumps. The lift of a discharge valve should not exceed one-sixteenth of an inch, and that of a receiving valve should not exceed one-eighth.

As our brake apparatus has now been in use some fourteen years, a large number of pumps are partially worn out. We will furnish a new pump of the style shown in Plate B6, or B7, at the regular price of two hundred dollars, and allow a credit of one hundred dollars for the old pump if returned to us, making the cost of the new pump but one hundred dollars. This exchange is much cheaper than to go to the cost of repairing a nearly worn-out pump. We especially recommend the eight-inch pump, B7, as it will furnish fifty per cent. more air than the standard pump.



EIGHT-INCH AIR-PUMP.

PLATE B7 shows a pump designed especially for use in freight service, as it furnishes a large volume of air in a short time. The operation is the same as that of the pump shown on Plate B6, and no further explanation is necessary.

DETAILS OF EIGHT-INCH AIR-PUMP.

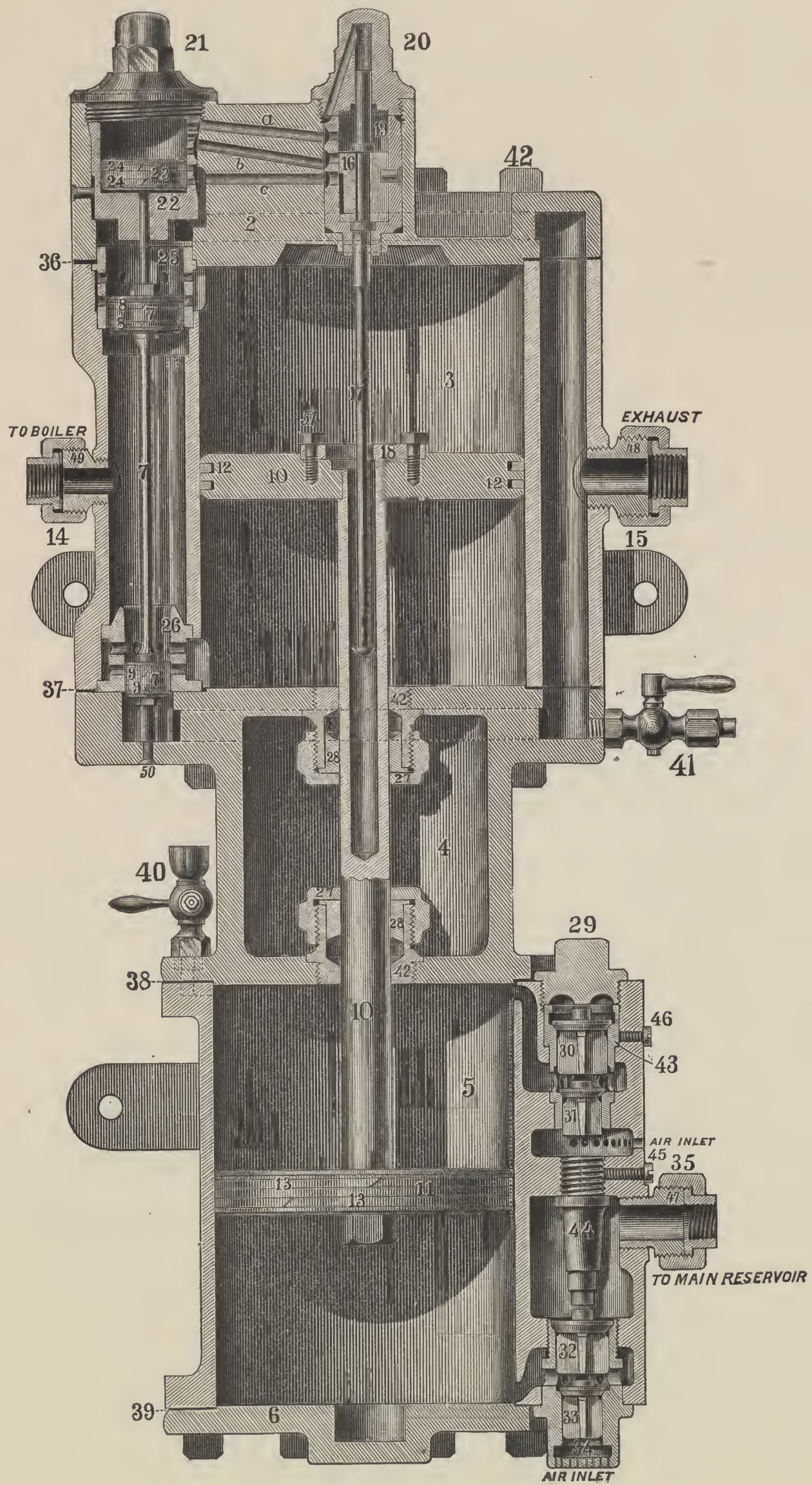
PLATE B7.

No.	No.
1. Eight-inch Pump, complete. (No. 5, Plate B5.)	25. Upper Main Valve Bush.
2. Top Head, with Reversing-cylinder, Piston, and Valve Bushes.	26. Lower Main Valve Bush.
3. Steam-cylinder, with Main Valve and Bushes.	27. Packing-nut.
4. Center-piece.	28. Packing-gland.
5. Air-cylinder Body, with Valves.	29. Upper-valve Chamber Cap.
6. Air-cylinder Head.	30. Upper Discharge Valve.
7. Main Valve.	31. Upper Receiving-valve.
8. Upper Main Valve Packing-ring.	32. Lower Discharge Valve.
9. Lower Main Valve Packing-ring.	33. Lower Receiving-valve.
10. Steam Piston and Rod.	34. Lower-valve Chamber Cap.
11. Air-piston.	35. Reservoir Union.
12. Steam-piston Packing-ring.	36. Upper Steam-cylinder Gasket.
13. Air-piston Packing-ring.	37. Lower Steam-cylinder Gasket.
14. Steam-pipe Union.	38. Upper Air-cylinder Gasket.
15. Exhaust-pipe Union.	39. Lower Air-cylinder Gasket.
16. Reversing-valve.	40. Air-cylinder Oil-cup.
17. Reversing-valve Stem.	41. Drain Cock.
18. Reversing-valve Plate.	42. Cylinder-head Bolt.
19. Reversing-valve Bush.	43. Valve Chamber Bush.
20. Reversing-valve Chamber Cap.	44. Discharge Valve Stop.
21. Reversing-cylinder Cap.	45. Valve Stop Set Screw.
22. Reversing cylinder.	46. Chamber Bush Set Screw.
23. Reversing-piston.	47. Reservoir Union Stud.
24. Reversing-piston Packing-ring.	48. Exhaust-pipe Union Stud.
	49. Steam-pipe Union Stud.
	50. Main Valve Stop.
	51. Reversing-valve Plate Bolt.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid mistakes.

EIGHT-INCH AIR-PUMP.

PLATE B 7.



NARROW-GAUGE AIR-PUMP.

PLATE B8 shows the standard pump for narrow-gauge equipment, the construction and operation being the same as the standard pump, except that a different air-valve arrangement is used.

DETAILS OF NARROW-GAUGE PUMP.

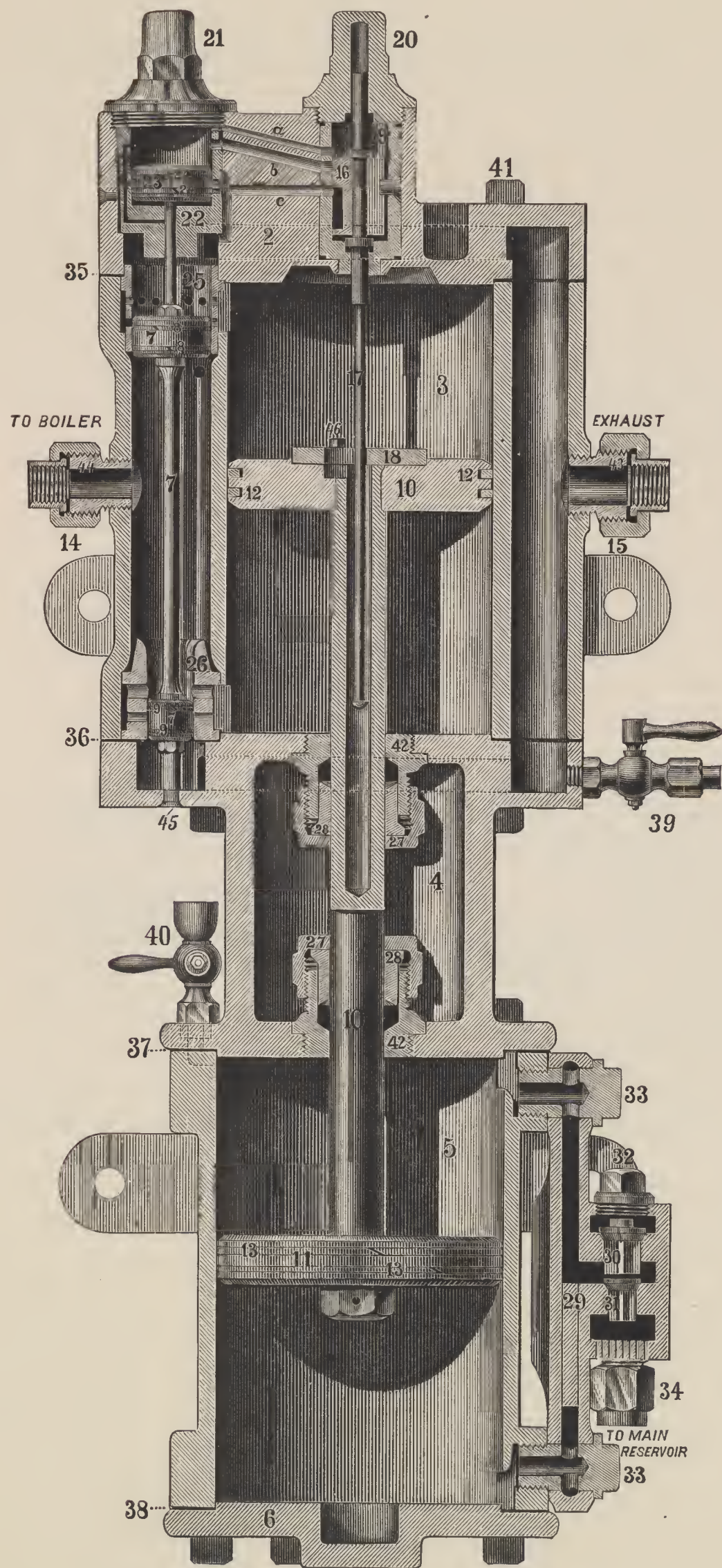
PLATE B8.

No.	No.
1. Engine and Pump, complete. (No. 6, Plate B5.)	21. Reversing-cylinder Cap.
2. Steam-cylinder Head, with Reversing-cylinder, Piston, and Valve Bushes.	22. Reversing-cylinder.
3. Steam-cylinder, with Main Valve and Bushes.	23. Reversing-piston.
4. Center-piece.	24. Reversing-piston Packing-ring.
5. Air-cylinder.	25. Upper Main Steam-valve Bush.
6. Air-cylinder Head.	26. Lower Main Steam-valve Bush.
7. Main Steam-valve.	27. Piston-packing Nut.
8. Packing-ring for Upper Piston-valve.	28. Piston-packing Gland.
9. Packing-ring for Lower Piston-valve.	29. Air-valve Case.
10. Steam-piston and Rod.	30. Discharge-valve.
11. Air-piston.	31. Receiving-valve.
12. Steam-piston Packing-ring.	32. Valve-chamber Cap.
13. Air-piston Packing-ring.	33. Side-pipe Bolt.
14. Half-inch Union.	34. Air-discharge Pipe Union.
15. Three-quarter-inch Union.	35. Upper Steam-cylinder Gasket.
16. Reversing-valve.	36. Lower Steam-cylinder Gasket.
17. Reversing-valve Stem.	37. Upper Air-cylinder Gasket.
18. Reversing-valve Plate.	38. Lower Air-cylinder Gasket.
19. Reversing-valve Bush.	39. Drain-cock.
20. Reversing-valve Cap.	40. Air-cylinder Oil-cup.
	41. Cylinder-head Bolt.
	42. Piston Packing-case.
	43. Exhaust Union Stud.
	44. Steam-pipe Union Stud.
	45. Main-valve Stop.
	46. Reversing Valve-plate Bolt.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

NARROW-GAUGE AIR-PUMP.

PLATE B8.



TRIPLE VALVE.

PLATE B9 illustrates the standard triple valve with cast-iron case, lined with brass bushes. The operation of the triple valve is fully described in connection with Plate B4.

DETAILS OF TRIPLE VALVE.

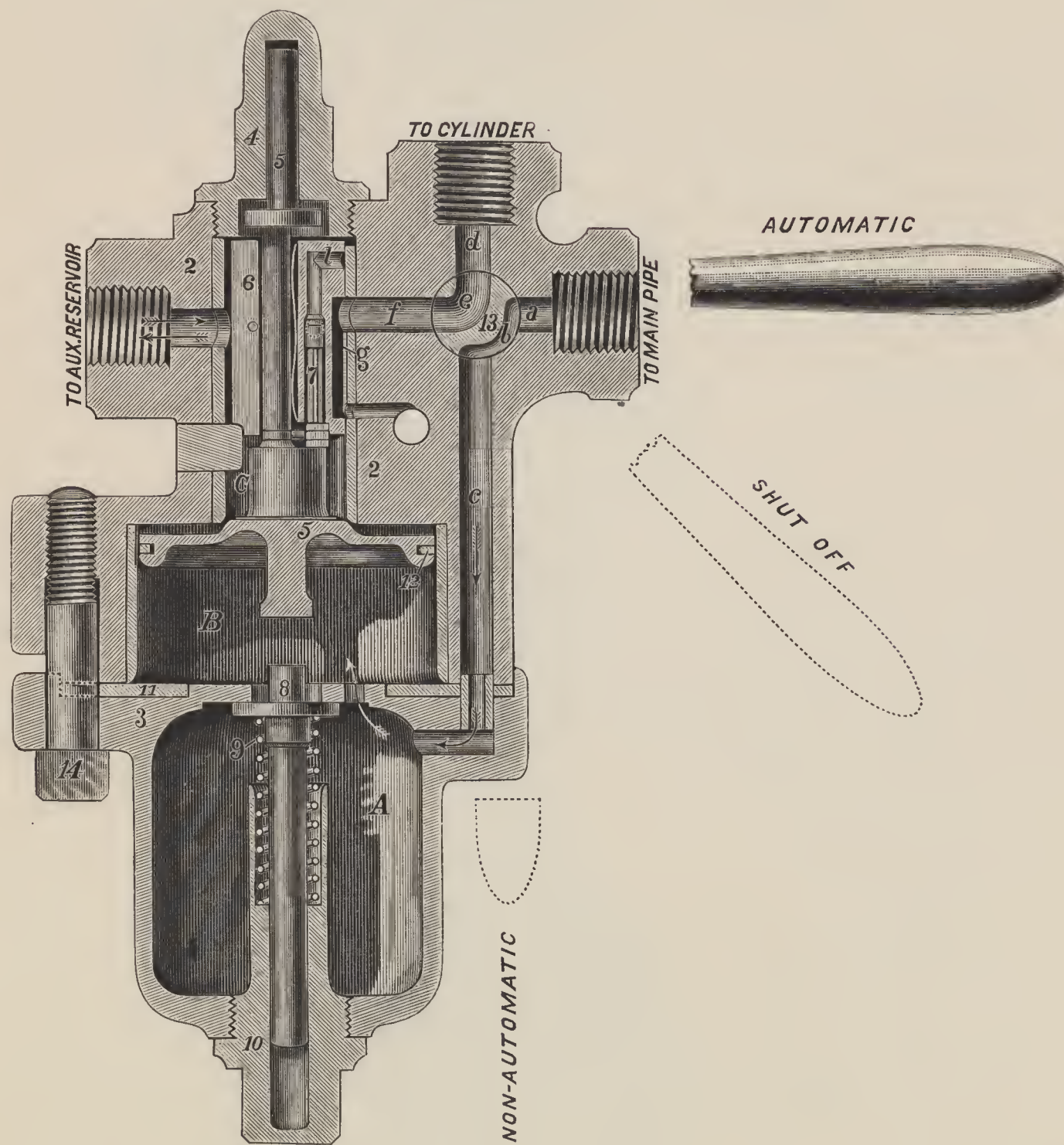
PLATE B9.

No.	No.
1. Triple Valve, complete. (No. 22, Plate B5.)	8. Graduating-stem.
2. Triple-valve Case.	9. Graduating-stem.
3. Lower Cap.	10. Bottom Nut.
4. Upper Cap.	11. Rubber Packing-ring.
5. Piston.	12. Piston Packing-ring.
6. Slide-valve.	13. Four-way Cock Plug.
7. Graduating-valve.	14. Bolt.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

TRIPLE VALVE.

PLATE B9.



TRIPLE VALVE, WITH BRASS CASE.

PLATE B10 shows a triple valve of the same general construction as the preceding one, but with brass case. The triple valves originally sent out can be altered to this internal arrangement, and are being so altered in large quantities. We recommend the use of the triple valve shown on Plate B9, as it is much stronger and less liable to damage. We furnish the style shown herewith only to roads who already have the greater part of their equipment fitted with the original triple valve, and desire uniformity in their pipe arrangement.

DETAILS OF TRIPLE VALVE, WITH BRASS CASE.

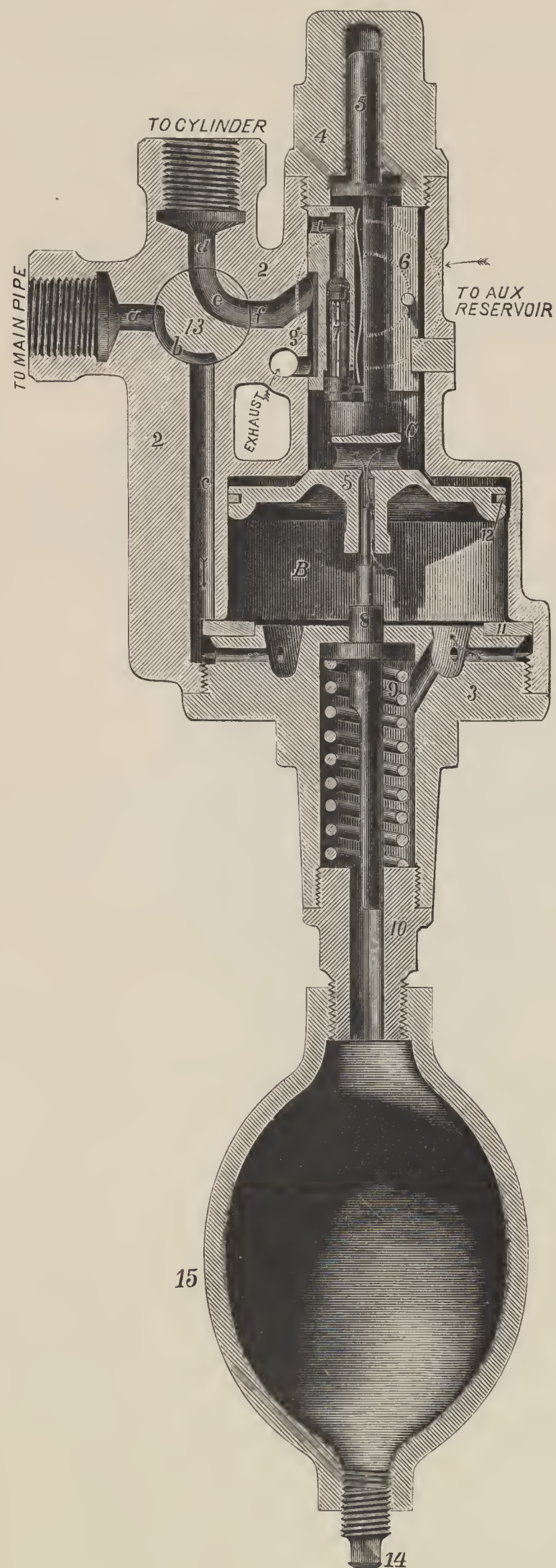
PLATE B10.

No.	No.
1. Triple Valve, with Brass Case, complete. (No. 23, Plate B5.)	8. Graduating-stem.
2. Triple-valve Body.	9. Graduating-spring.
3. Lower Cap.	10. Bottom-nut.
4. Upper Cap.	11. Gasket.
5. Piston.	12. Piston Packing-ring.
6. Slide-valve.	13. Four-way Cock Plug.
7. Graduating-valve.	14. Drain-cup Plug.
	15. Drain-cup.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

TRIPLE VALVE, WITH BRASS CASE.

PLATE BIO.



DETAILS OF ENGINEER'S BRAKE-VALVE.

PLATE B11.

Engineer's Brake-Valve, complete, No. 12, Plate B5.

No.	No.
1. Handle.	10. Main-valve Spring.
2. Body.	11. Lower Cap.
3. Top-valve.	12. Union.
4. Top-valve Spring.	13. Stud-nut (not shown).
5. Washer.	14. Gauge-pipe Nut (not shown).
6. Main-valve.	15. Handle Spring.
7. Feed-valve.	16. Handle-spring Nut.
8. Feed-valve Seat.	17. Main-valve Spring.
9. Feed-valve Spring.	

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

ENGINEER'S BRAKE-VALVE.

PLATE BII shows the engineer's brake-valve, the handle of which terminates in a screw with a coarse thread, which compresses a spring 4, upon the top valve 3; this top valve fits into a slot in the handle 1, and into a slot in the main valve 6, so that the handle and the two valves must turn simultaneously. In the position shown in the drawing, which is for releasing the brakes, the top valve 3, leading to the atmosphere, is kept closed by the compression of the spring 4, and the air passes freely from the main reservoir to the brake-pipe, through the opening of the main valve and the body of the brake-valve. After the brakes are off, the handle is moved against the second stop, a short distance to the right, which turns the main valve so that the main passages to the brake-pipe are closed. Air can, however, pass through the small valve 7, and thence to the brake-pipe through a small opening not shown in the drawing. This small valve 7 is held down by a spring whose resistance is equal to 20 pounds per square inch; hence the pressure in the main reservoir will always be 20 pounds greater than that in the brake-pipe, which surplus pressure insures the certain release of the brakes when desired. To apply the brakes, the handle is moved still farther to the right, when the opening from the small valve 7 is also closed, cutting off all communication from the main reservoir to the brake-pipe; at the same time the action of the screw lifts the handle and relieves the spring 4 from pressure, when the air in the brake-pipe lifts the valve 3, and escapes, until an equilibrium is established between the air-pressure and the pressure of the spring on the valve 3, thus reducing the pressure in the brake-pipe to an extent corresponding to the distance which the handle is moved.

To apply the brakes suddenly, the handle is turned the entire distance to the right, which relieves the spring of all compression, allowing the valve 3 to rise, and all of the air in the brake-pipe to escape.

After the train is stopped, the brakes are released by turning the handle to the position shown in the drawing.

ENGINEER'S BRAKE-VALVE, WITH EQUALIZING DISCHARGE.

PLATE B12 shows the engineer's brake-valve with equalizing discharge arrangement, which performs the functions of the ordinary engineer's valve, and at the same time provides for a difficulty which sometimes arises, particularly on long trains, when the engineer, instead of allowing the air to escape slowly from the brake-pipe in applying the brakes, allows a considerable amount of air to escape in a short time and then closes the valve suddenly. In this case the pressure from the rear of the train has not time to become equalized with that in the front, and, flowing forward, has a tendency to release the brakes on the cars nearest the engine. The equalizing arrangement provides for a constant flow of air from the brake-pipe until the pressure is uniform throughout the train, insuring a uniform application of the brakes to the various cars; also the engineer operates this valve in the same manner, without regard to the number of cars that may be in the train.

The plate shows the valve in the position for releasing the brakes; the pressure from the main reservoir passing through the rotary valve 13 and to the main brake-pipe, as shown by the arrows. While running, the handle of the valve is turned to the position shown in the diagram, when the air enters through the feed port, passing the feed valve 32, which is held to its seat by the spring 33, which causes an excess of pressure in the main reservoir over that in the brake-pipe equal to the strength of the spring 33, and insures a quick release of the brakes.

The chamber A is connected to a small reservoir, not shown in the cut, which simply serves to increase the effective capacity of the chamber. To apply the brakes, the handle is turned to the position for application shown in the diagram, and a portion of the air in the chamber allowed to escape from the supply port, causing a corresponding reduction of pressure in the chamber, after which the handle is turned to put the valve on the lap. The excess of pressure in the main brake-pipe over that in the chamber A forces the piston 18 up, unseating the valve 22 and allowing air to escape through

the exhaust from brake-pipe until the pressure in the brake-pipe is equal to that in the chamber, the valve 22 remaining open until the pressure is equalized throughout the train, when this valve is returned to its seat by the spring 27. If a very considerable reduction of pressure is made in the chamber A, the piston 18 will move far enough to carry with it the slide valve 23 and allow the air to escape more rapidly by uncovering the two exhaust ports. In case of emergency, the handle may be turned to the extreme right connecting the direct application port with a large exhaust port and releasing the pressure in the brake-pipe with great rapidity.

DETAILS OF ENGINEER'S BRAKE-VALVE WITH EQUALIZING ARRANGEMENT.

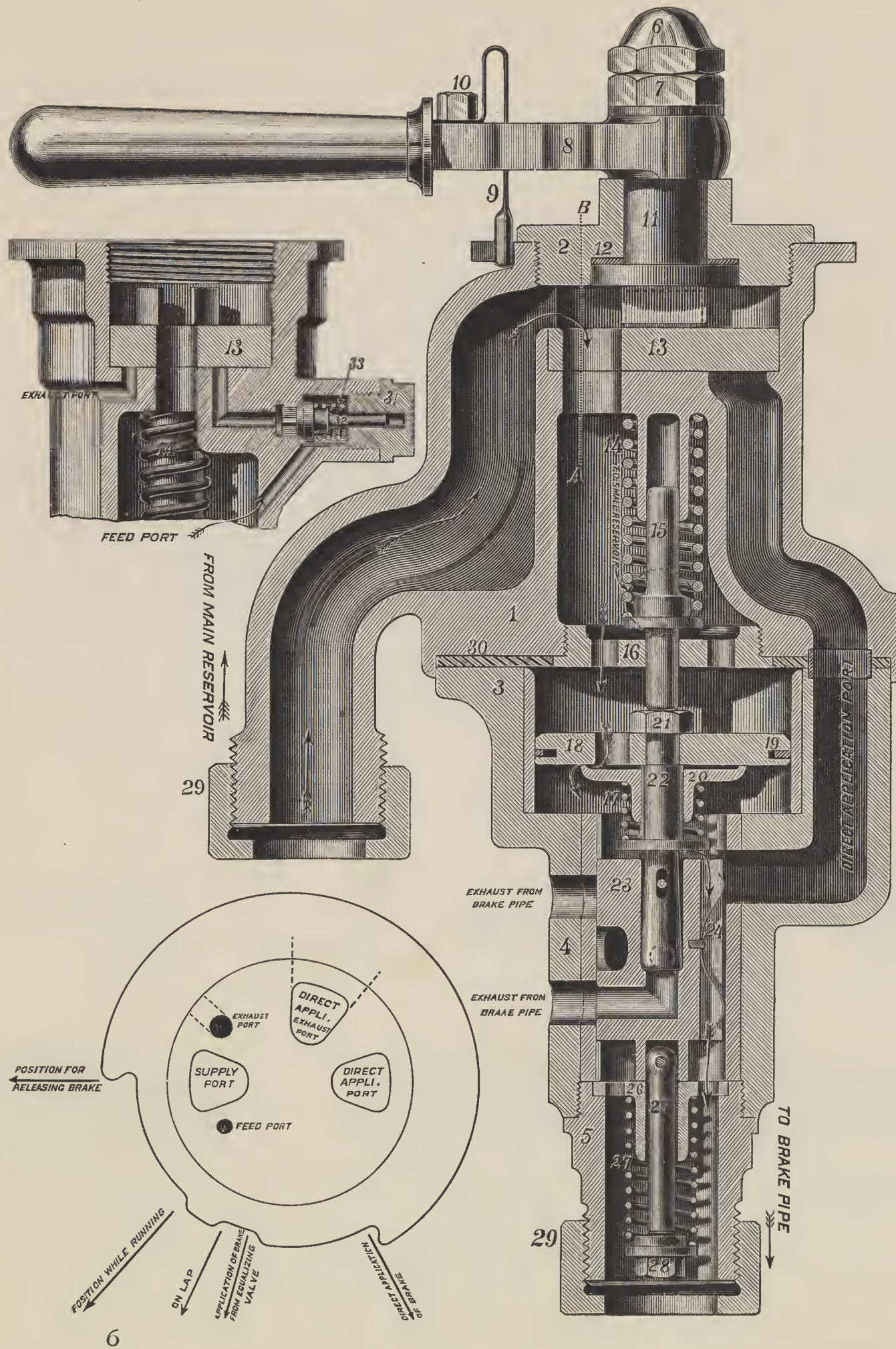
PLATE B12.

No.	No.
1. Valve Body.	18. Piston-valve.
2. Top Cap.	19. Piston Ring.
3. Bottom Case.	20. Check-valve.
4. Bottom Case Bush.	21. Piston Nut.
5. Bottom Cap.	22. Exhaust-valve.
6. Jam Nut.	23. Slide-valve.
7. Top Nut.	24. Slide-valve Spring.
8. Handle.	25. Slide-valve Stem.
9. Handle Spring.	26. Slide-valve Stem Guide.
10. Handle Spring Nut.	27. Slide-valve Stem Spring.
11. Rotary-valve Key.	28. Slide-valve Stem Nut.
12. Washer.	29. Union.
13. Rotary-valve.	30. Gasket.
14. Graduating Spring.	31. Cap Nut.
15. Graduating Stem.	32. Feed-valve.
16. Center Nut.	33. Feed-valve Spring.
17. Check-valve Spring.	

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

ENGINEER'S BRAKE-VALVE, WITH EQUALIZING ARRANGEMENT.

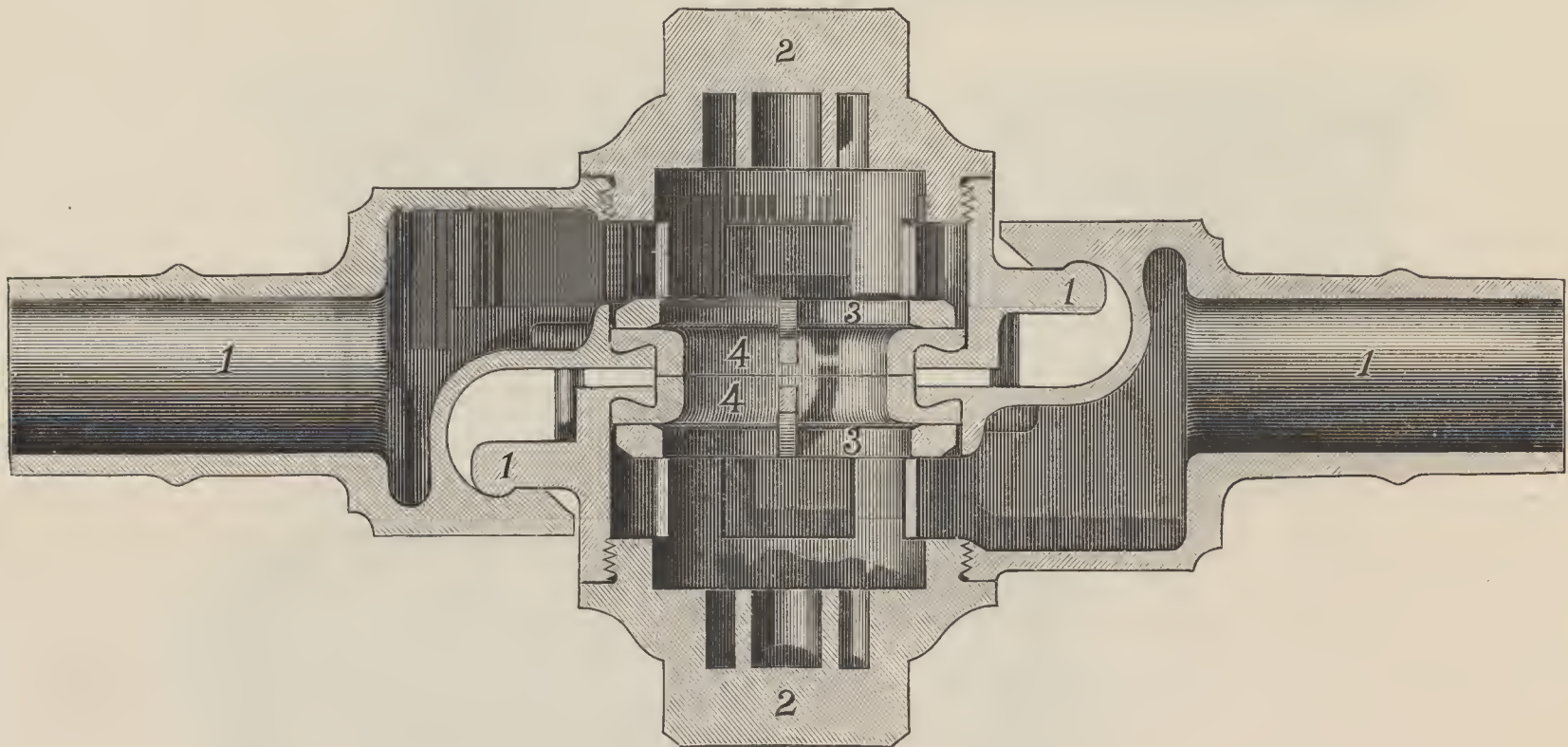
PLATE B12.



HOSE COUPLING.

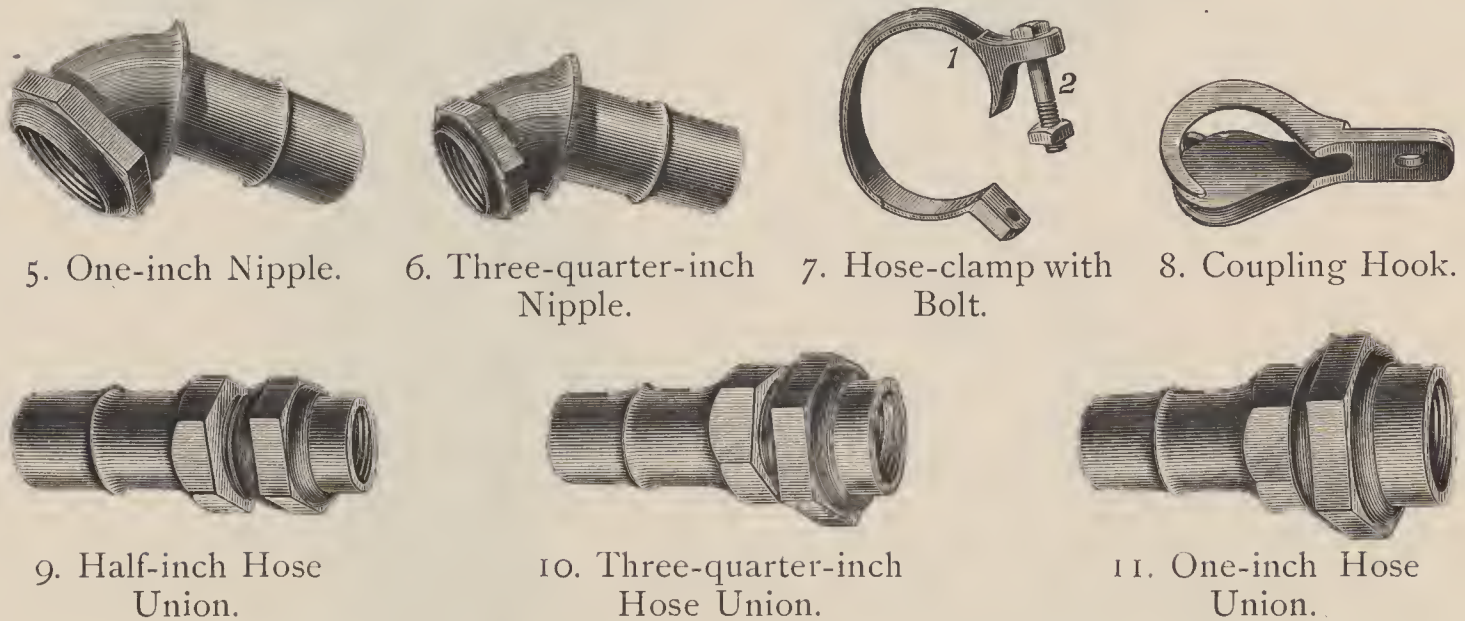
PLATE B13 shows the coupling used with the automatic brake, the construction of which will be readily understood. The various combinations of hose and couplings are shown on Plate B5.

PLATE B13.



1. Coupling-case. 2. Coupling-cap. 3. Packing-ring Washer. 4. Packing-ring.

DETAILS OF COUPLINGS WITHOUT VALVES.



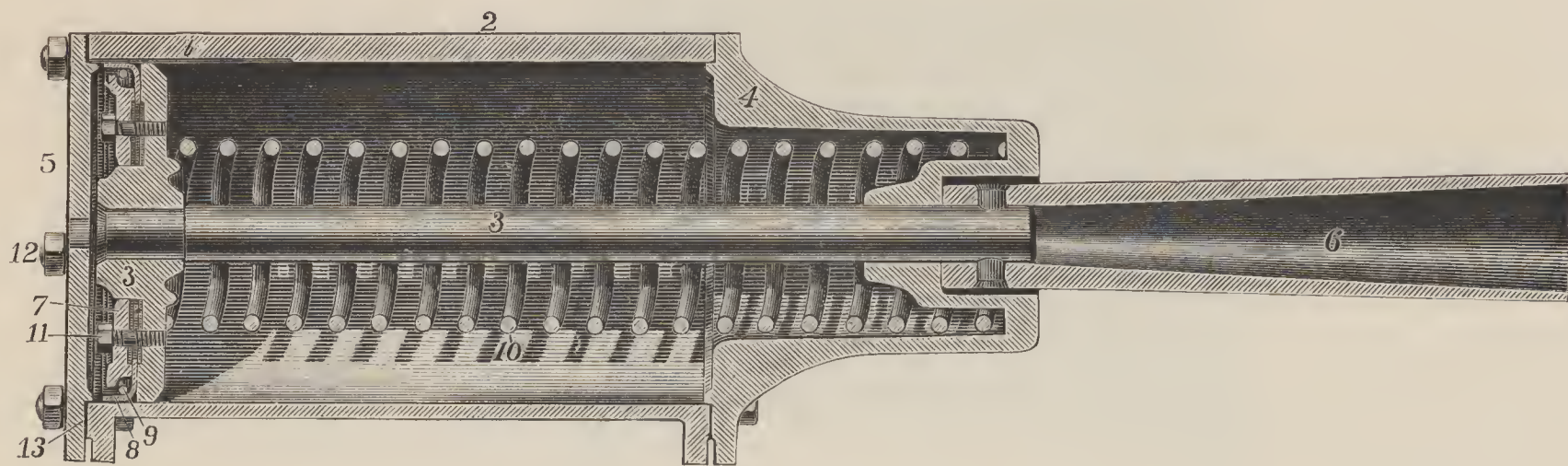
5. One-inch Nipple. 6. Three-quarter-inch Nipple. 7. Hose-clamp with Bolt. 8. Coupling Hook.
9. Half-inch Hose Union. 10. Three-quarter-inch Hose Union. 11. One-inch Hose Union.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors.

TENDER CYLINDER.

PLATE B14 shows the brake-cylinder designed for use on tenders, the construction of which is so clearly shown by the drawing that no further explanation is necessary.

PLATE B14.



DETAILS OF TENDER CYLINDER.

PLATE B14.

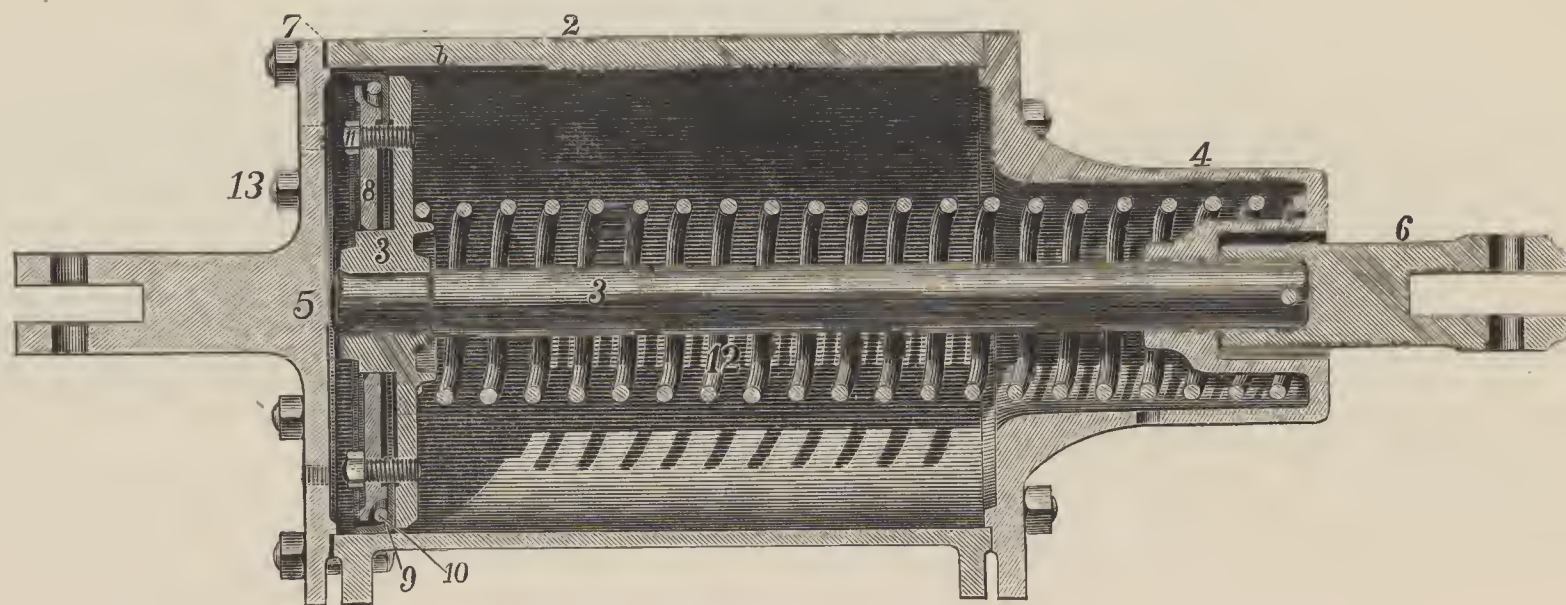
No.	No.
1. Tender Cylinder, complete. (No. 8, Plate B5.)	7. Piston-follower.
2. Cylinder Body.	8. Piston Packing-leather.
3. Piston and Rod.	9. Packing-leather Expander.
4. Back Head.	10. Release-spring.
5. Front Head.	11. Piston-follower Bolt.
6. Piston-sleeve.	12. Cylinder-head Bolt.
	13. Gasket.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

STANDARD TEN-INCH CAR-CYLINDER.

PLATE B15 shows the car-cylinder used on standard-gauge passenger cars, the construction of which will be understood from the drawing.

PLATE B15.



DETAILS OF STANDARD TEN-INCH CAR-CYLINDER.

PLATE B15.

No.

1. Ten-inch Car-cylinder, complete.

(No. 9, Plate B5.)

2. Cylinder Body.

3. Piston and Rod.

4. Back Cylinder-head.

5. Front Cylinder-head.

6. Cross Head.

No.

7. Gasket.

8. Piston-follower.

9. Piston Packing-leather.

10. Packing-leather Expander.

11. Piston-follower Bolt.

12. Release-spring.

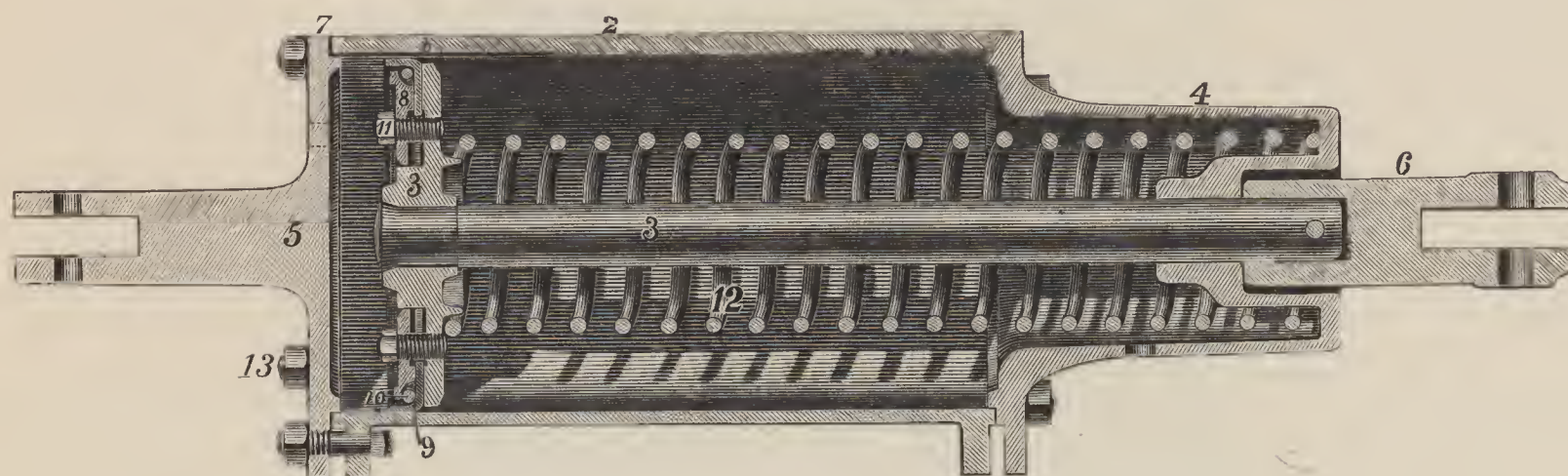
13. Cylinder-head Bolt.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

EIGHT-INCH CAR-CYLINDER, NARROW GAUGE.

PLATE B16 shows the eight-inch car-cylinder, which is used on narrow-gauge passenger cars.

PLATE B16.



DETAILS OF EIGHT-INCH CAR-CYLINDER—NARROW GAUGE.

PLATE B16.

No.		No.	
1.	Eight-inch Car-cylinder, complete. (No. 7, Plate B5.)	7.	Gasket.
2.	Cylinder Body.	8.	Piston-follower.
3.	Piston and Rod.	9.	Piston Packing-leather.
4.	Back Cylinder-head.	10.	Packing-leather Expander.
5.	Front Cylinder-head.	11.	Piston-follower Bolt.
6.	Cross Head.	12.	Release Spring.
		13.	Cylinder Head Bolt.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

EIGHT-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE B17 shows our standard eight-inch brake-cylinder for driving-wheels, the application of which will be clearly understood from the drawing. The air enters underneath the piston 3, and the cup-leather 7 makes an air-tight packing for the piston rod.

DETAILS OF EIGHT-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE B17.

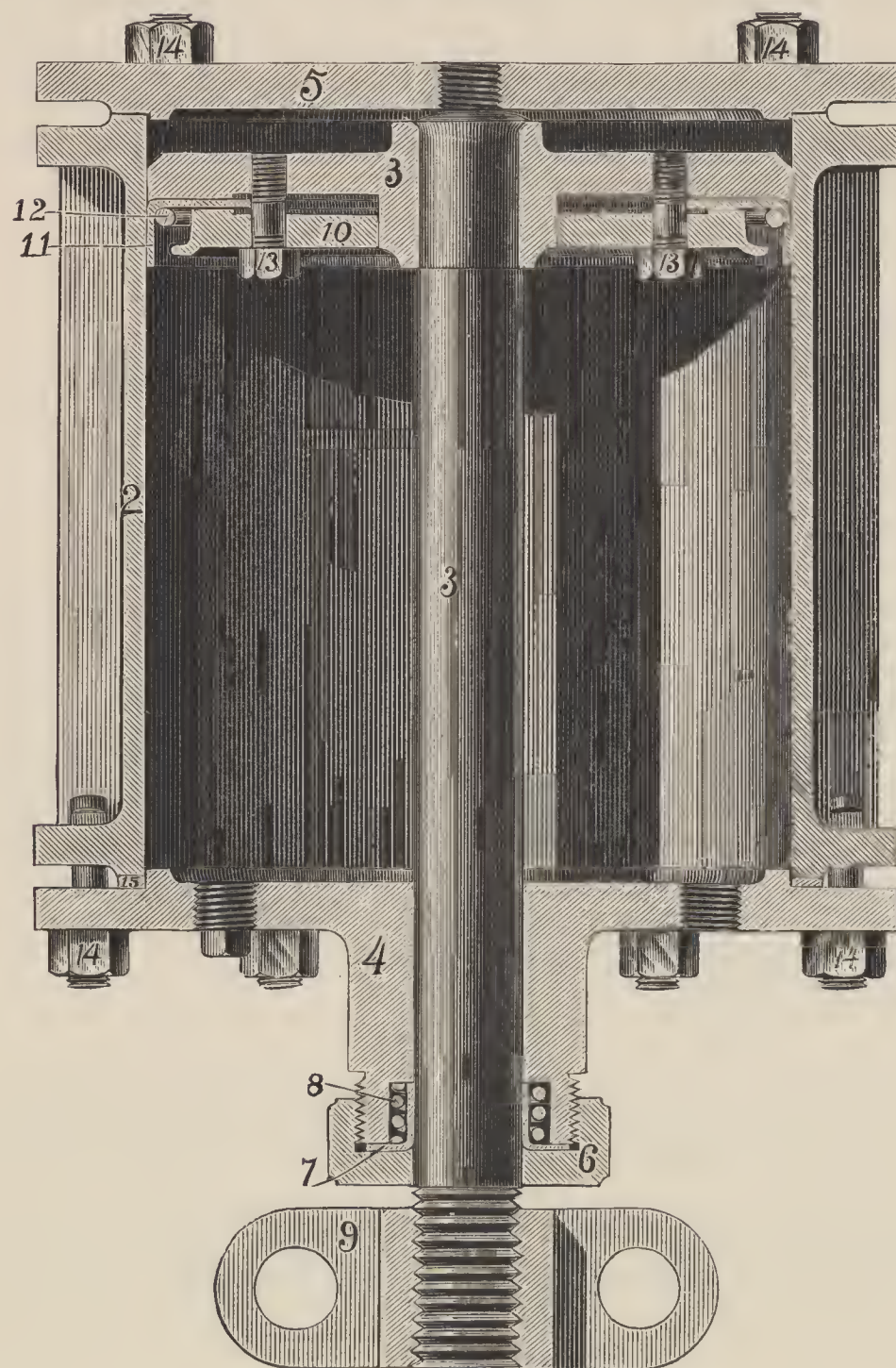
No.	No.
1. Eight-inch Brake-cylinder for Driving-wheels, complete. (No. 10, Plate B5.)	8. Piston Rod Packing-spring.
2. Cylinder Body.	9. Cross Head.
3. Piston Rod.	10. Piston-follower.
4. Lower Head.	11. Piston Packing-leather.
5. Upper Head.	12. Piston Packing-expander.
6. Piston Rod Packing-nut.	13. Piston-follower Bolts.
7. Piston Rod Cup-leather.	14. Cylinder Bolts.
	15. Gasket.

In ordering driver brake-cylinders, always refer to some drawing furnished by us, or send sketch of engine from which to prepare drawing.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors, and also refer to our drawing.

EIGHT-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE B17.



SIX-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE B18 shows a six-inch brake-cylinder for driving-wheels, which is used on narrow-gauge engines. Its operation is the same as that of the standard cylinder, shown on Plate B17.

DETAILS OF SIX-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE B18.

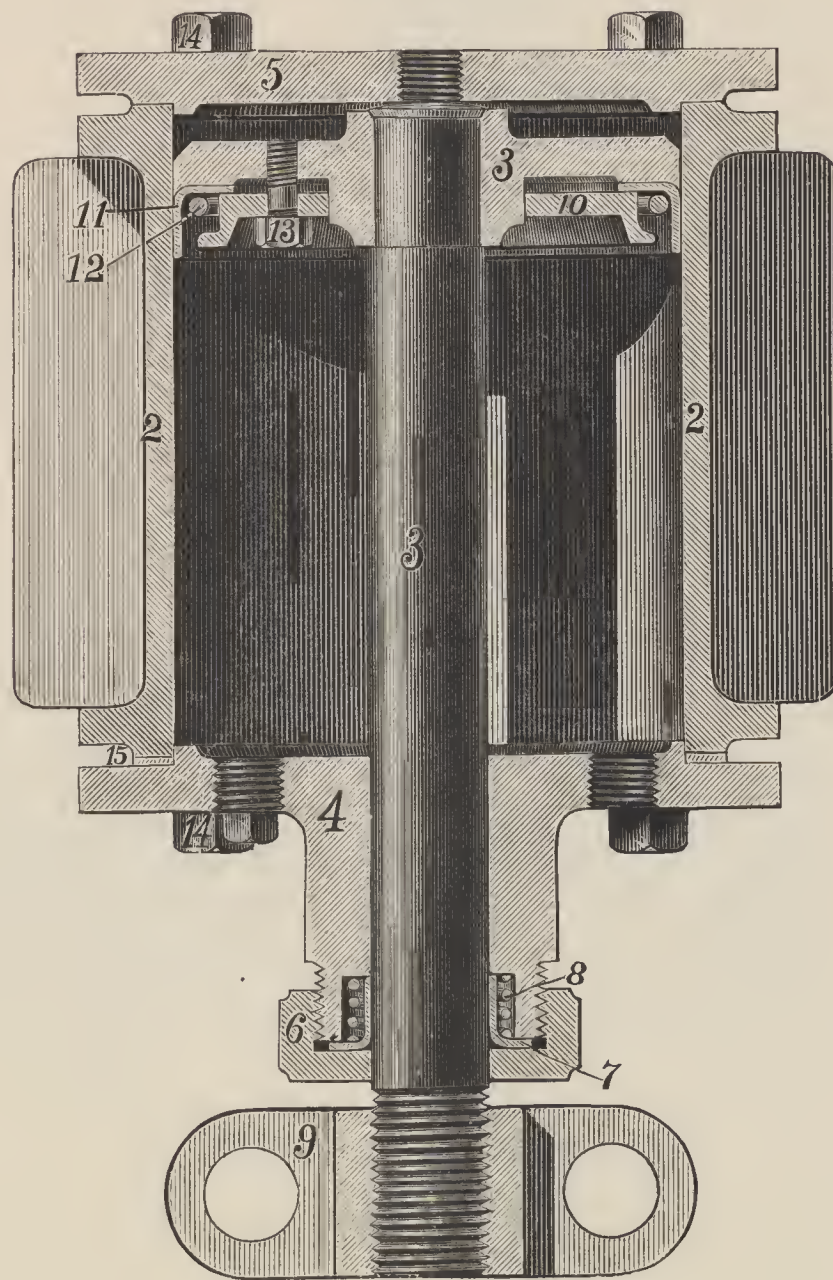
No.	No.
1. Six-inch Brake-cylinder for Driving-wheels, complete. (No. 11, Plate B5.)	8. Piston Rod Packing-spring.
2. Cylinder Body.	9. Cross Head.
3. Piston and Rod.	10. Piston-follower.
4. Lower Head.	11. Piston Packing-leather.
5. Upper Head.	12. Packing-leather Expander.
6. Piston Rod Packing-nut.	13. Piston-follower Bolts.
7. Piston Rod Cup-leather.	14. Cylinder Bolts.
	15. Gasket.

In ordering driver brake-cylinders, always refer to some drawing furnished by us, or send sketch of engine from which to prepare drawing.

In ordering detached parts for repairs, please specify the plate and the number of each piece accurately, to avoid errors, and also refer to our drawing.

SIX-INCH BRAKE-CYLINDER FOR DRIVING-WHEELS.

PLATE B18.



DETAILS OF PUMP GOVERNOR.

PLATE B19.

No.	No.
1. Governor Body.	11. Steam Pipe Swivel.
2. Lower Stud.	12. Release Valve Spring.
3. Lower Stud Nut.	13. Release Valve.
4. Diaphragm Cap.	14. Diaphragm Stem.
5. Spring Box.	15. Regulating Nut.
6. Waste Pipe Stud.	16. Regulating Spring.
7. Stud Gland.	17. Diaphragm Nut.
8. Wheel.	18. Diaphragm Plate.
9. Valve Stem.	19. Union Nut.
10. Piston Valve.	

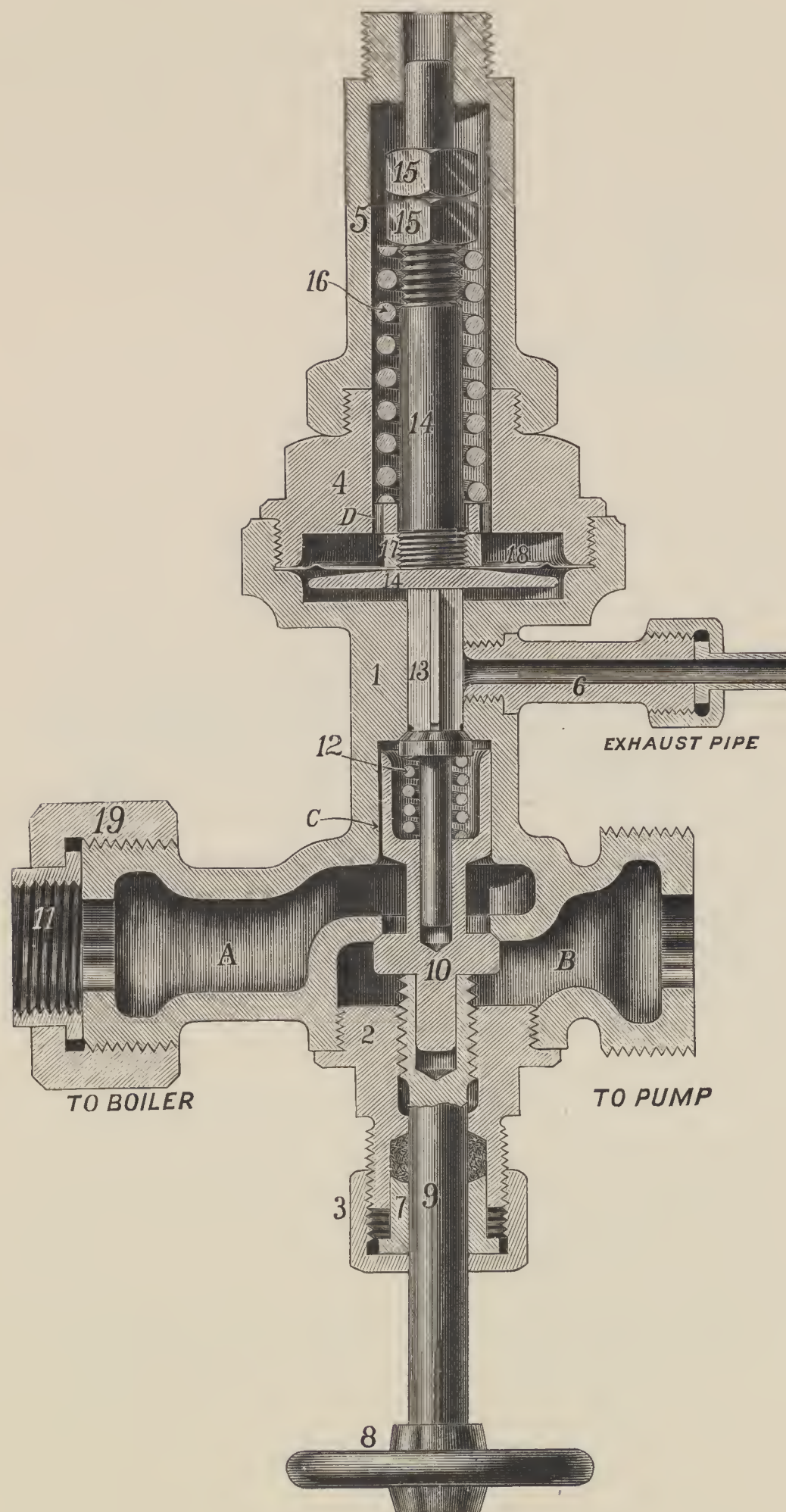
In ordering governors, please state whether for six inch or for eight inch pumps.

In ordering detached parts for repairs, please specify the plate and number of each piece accurately, to avoid errors.

PUMP GOVERNOR.

PLATE B19.

TO TRAIN PIPE



PUMP GOVERNOR.

PLATE B19.

We illustrate herewith a Pump Governor designed to take the place of the Pump Regulator, shown in plate A, 19, of Catalogue of 1882, the object of which is to automatically cut off the supply of steam to the pump, when the air pressure in the train pipe exceeds a certain limit, say, 70 pounds.

The operation of this Governor is as follows: The wheel 8 is screwed down so as to permit the valve 10 to be unseated by the excess of pressure on the upper side of the valve, when steam passes through the openings A and B to the pump. A connection is made from the train pipe to the upper end of the governor, and the compressed air passes around the stem 14 to the upper side of the diaphragm plate 18, which is held to its position by the spring 16, which latter is of sufficient strength to resist a pressure of, say, 70 pounds per square inch on diaphragm. As soon as the air pressure on the diaphragm 18 exceeds this amount, it forces the diaphragm down, unseating the valve 13, and allowing the steam on the upper side of the valve 10 to escape through the exhaust 6, which causes an excess of steam pressure on the lower side of the valve 10, forcing the valve against its seat, and cutting off the supply of steam to the pump.

When the pressure in the train pipe is diminished by applying the brakes, the diaphragm is restored to the position shown, by the action of the spring 16. The valve 13 is seated by the spring 12, and the steam pressure passing through the port C accumulates on the upper side of the valve 10, forcing it down, and opening the passage for steam to the pump until the air pressure is again restored to the required limit of 70 pounds.

The use of this Governor not only prevents the carrying of an excessive air pressure by the engineers, which may result in the sliding of the wheels, but it also causes the accumulation of a surplus of air pressure in the main reservoir while the brakes are applied, which insures the release of the brakes without delay. It also obviates the unnecessary working of the pump when the desired air pressure has been obtained.

We furnish the Pump Governor at a charge of fifteen dollars each, and will supply it, when desired, without extra charge, with complete sets of engine fixtures.

AUXILIARY BRAKE-VALVE.

PLATE B20 shows the auxiliary brake-valve which is used where it is necessary, in descending heavy gradients, to apply the driver-brake independently, to keep the train in check while recharging, and the manner in which air is admitted to the cylinders will be readily understood from the drawing.

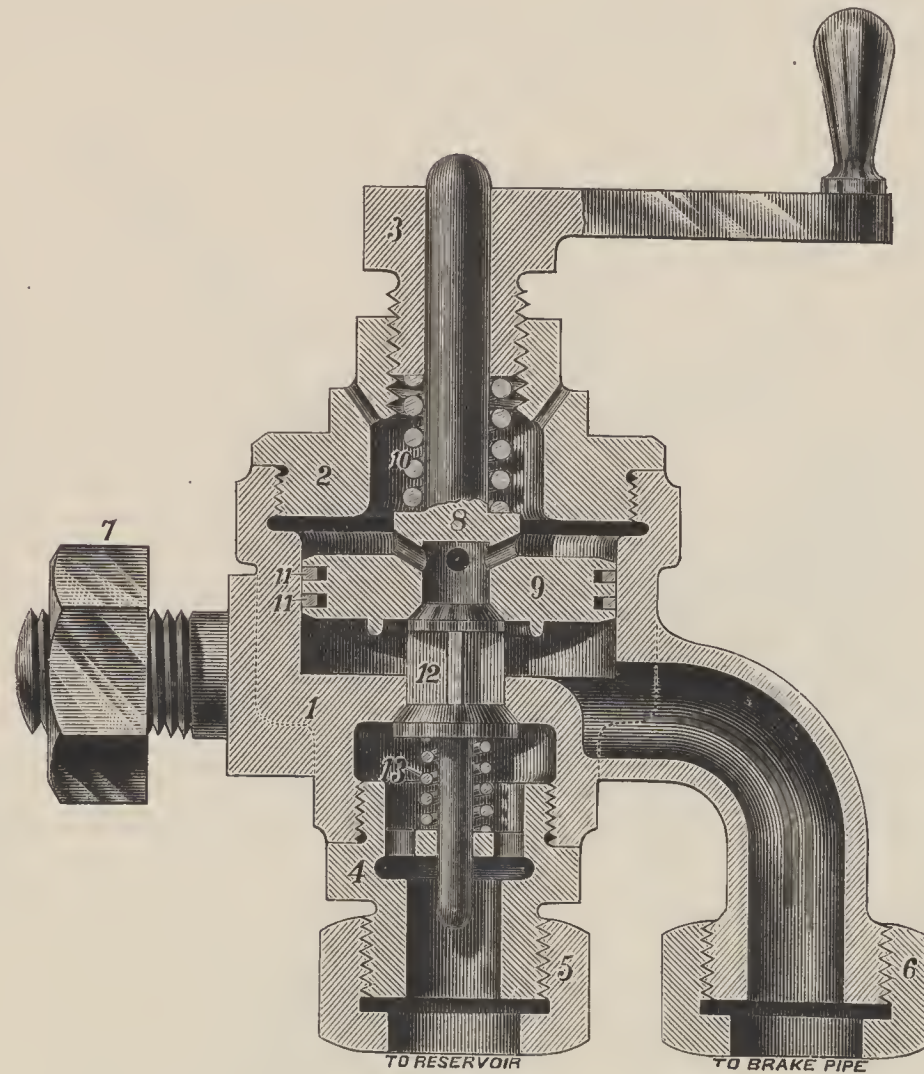


PLATE B20.

DETAILS OF AUXILIARY BRAKE-VALVE.

PLATE B20.

Auxiliary Brake-Valve, complete, No. 33, Plate B5.

No.

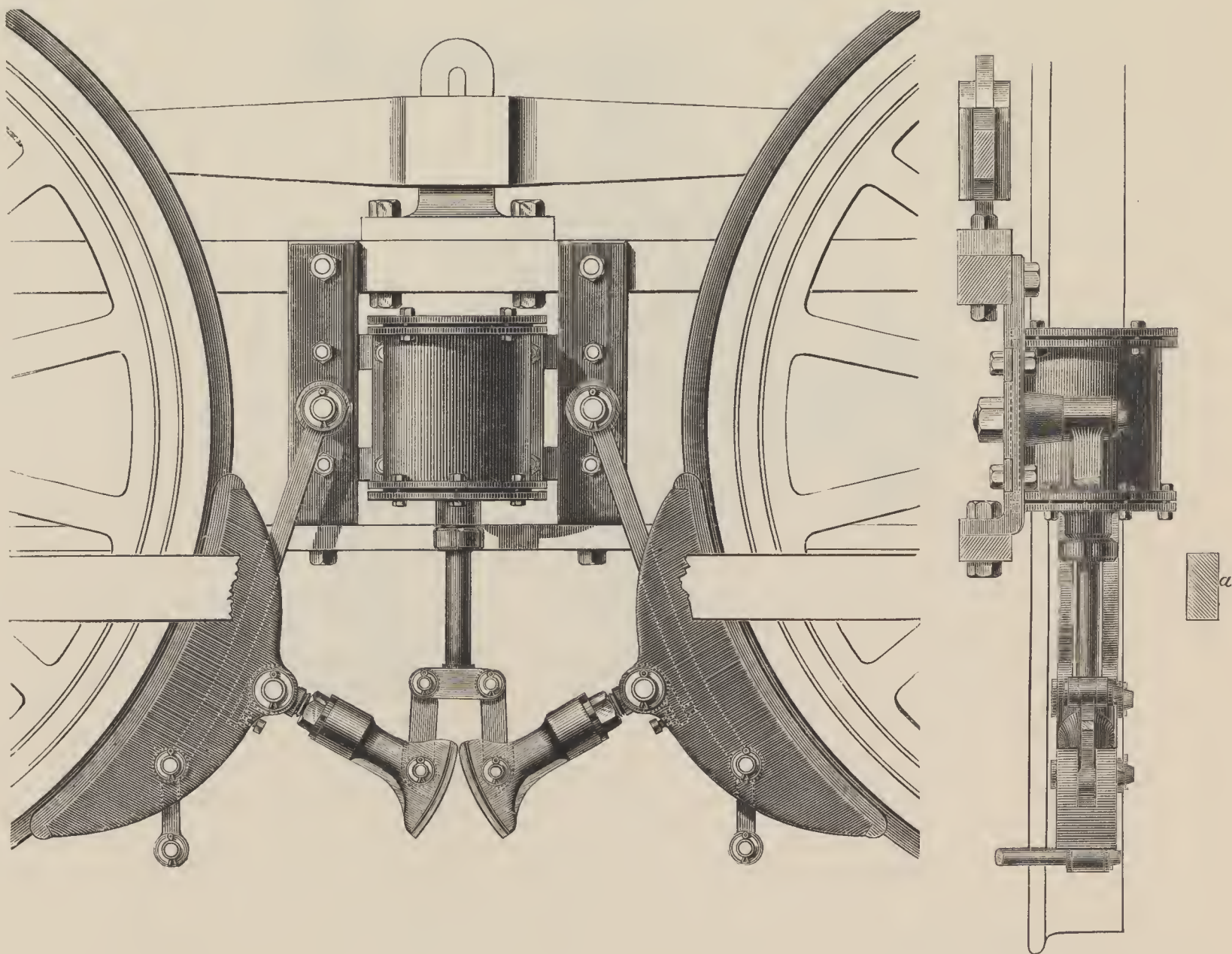
1. Valve-case.
2. Upper Cap.
3. Graduating Handle.
4. Bottom Cap.
5. Reservoir-pipe Union.
6. Brake-pipe Union.
7. Bracket-nut.

No.

8. Spring-guide.
9. Piston.
10. Upper Spring.
11. Piston Packing-ring.
12. Central Valve.
13. Lower Spring.

DRIVING-WHEEL BRAKES.

PLATE B21.



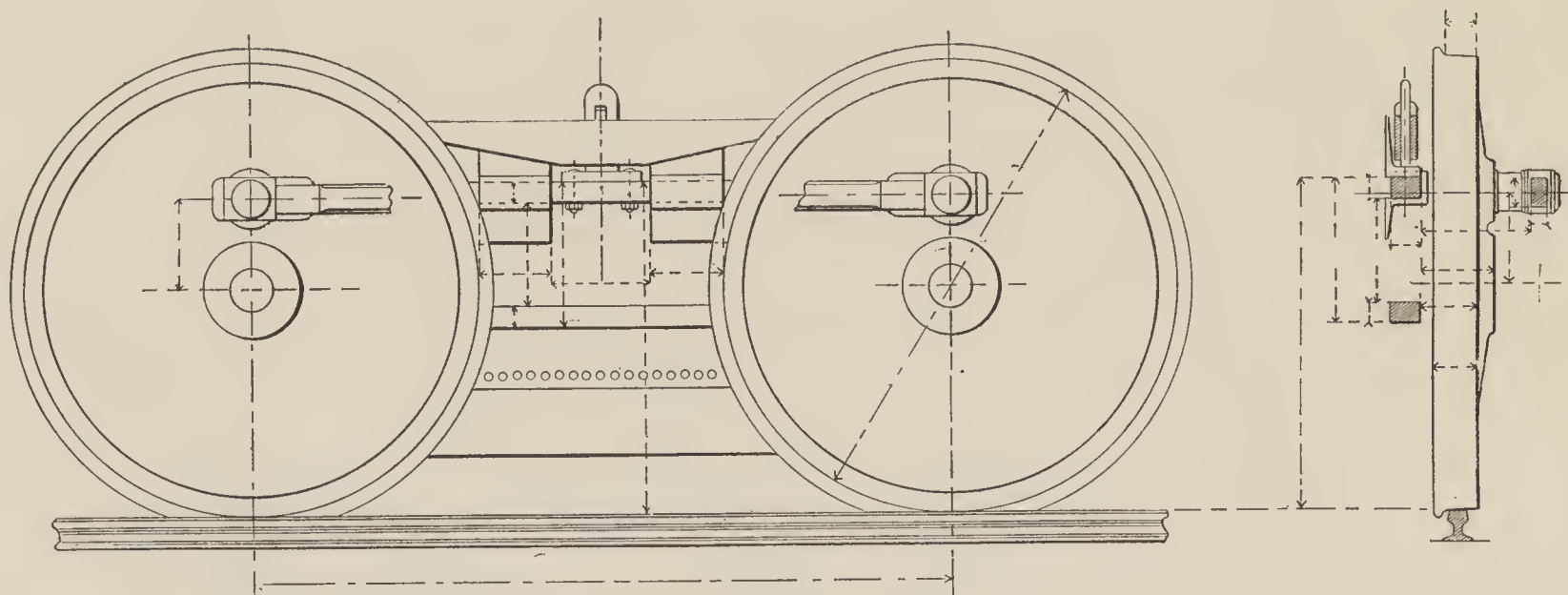
DRIVING-WHEEL BRAKES.

PLATE B21 gives two views of our driving-wheel brakes as applied to an ordinary engine, the operation of which is clearly shown by the drawing. As will be seen by reference to our agreement, we furnish the two cylinders for operating the driving-wheel brakes on engines without extra charge when desired.

When these brakes are ordered, it is necessary that a sketch of the engine for which they are intended should be sent us, showing a side view of the driving-wheels and frame, and a cross-section through the frame between driving-wheels, with the side rod in its highest position; the diameter of driving-wheels, distance from center to center, and distance from frame to rail, should also be given with the other dimensions. In addition, the approximate weight of the driving-wheels on the track should be stated. On receipt of this sketch, we prepare complete working drawings for the application of the castings and forgings necessary to work the driving-wheel brakes; these castings and forgings can be made by the parties desiring to use them, from the drawings which we furnish, or, if desired, we will furnish them at a price to be agreed upon, which will depend in a measure upon the class of engines to which the brakes are applied, one hundred and twenty-five dollars being the usual price.

We cannot too strongly urge the importance of having engines fitted with these driving-wheel brakes, as a large amount of braking power is secured at a very slight additional cost.

The experience of several years has demonstrated the fact that their use produces no injurious effect upon the driving-wheels or connecting-rods of the locomotive, while in freight service it has been found that an engineer can stop a train with the driving-wheel brakes in about the time required by the usual force of brakemen. It should be noted that the blocks are pressed against the wheels by two levers having curved faces rolling upon each other, and that the centers of these curves vary in position to the weight of the engine, and are at such points in all cases that a given pressure on the brake-piston will produce a nearly constant force against the brake-blocks at all points of the stroke. Details of the driving-wheel brake-cylinder are given on Plates B17 and B18.



DIMENSIONS REQUIRED.

Distance between centers of Wheels,
 Diameter
 Width between Wheels (across engine),
 Width of Tires,
 Width between Frames (across engine),
 Width of Frames,
 Thickness of Frames,
 Distance from center of Axle to top of
 Frame,
 Distance between top and bottom of
 Frame,

Position of Bracket for holding Frame
 to Fire-box,
 Dimensions of Bracket for holding
 Frame to Fire-box,
 Position of Side Rods,
 Position of Splash Boards (if any).

It is sometimes requisite to give diam-
 eter of boiler, and height of center from
 top of frame.

NAME OF ROAD. WEIGHT ON DRIVERS. CLASS OR NUMBER OF ENGINE.

This cut shows the information necessary from which to make working drawings for driving-wheel brakes, blanks for which will be furnished on application. Dimensions should be given in printed list as well as marked on the diagram.

TRAIN SIGNALING APPARATUS.

PLATE B22.

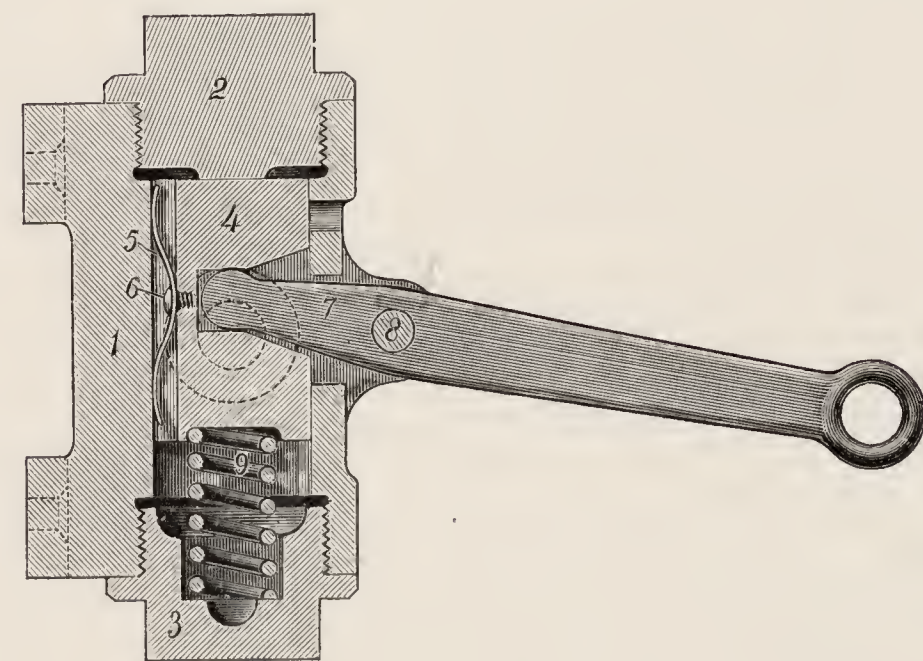
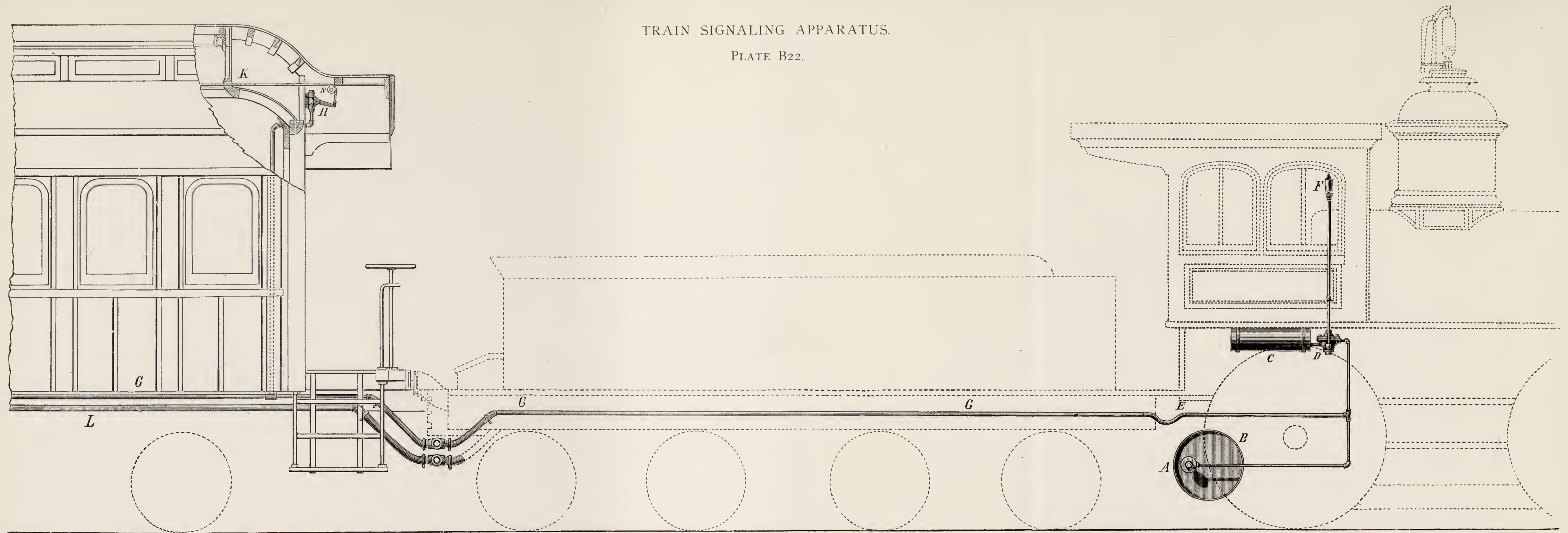


FIG. 1.

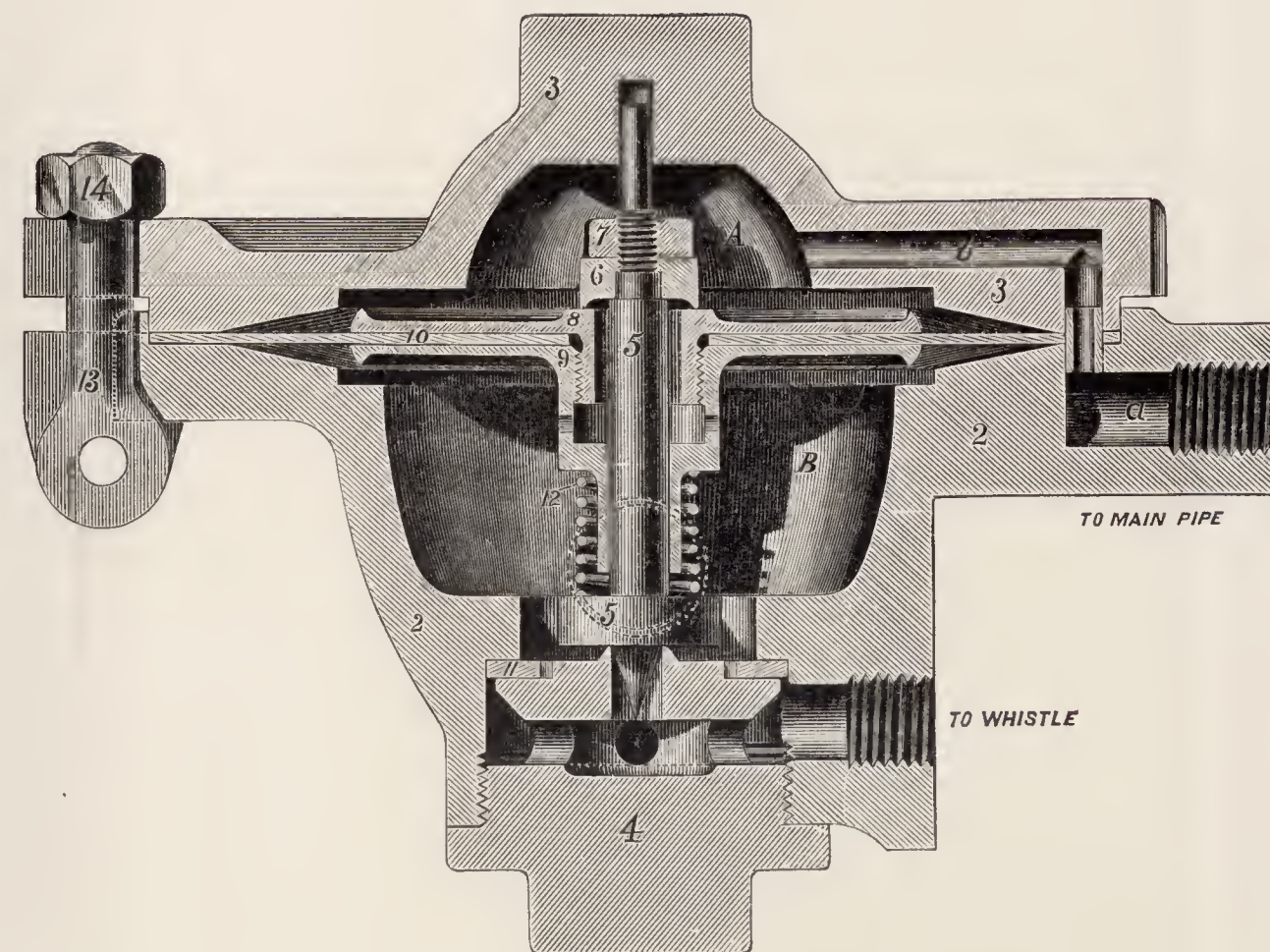


FIG. 2.

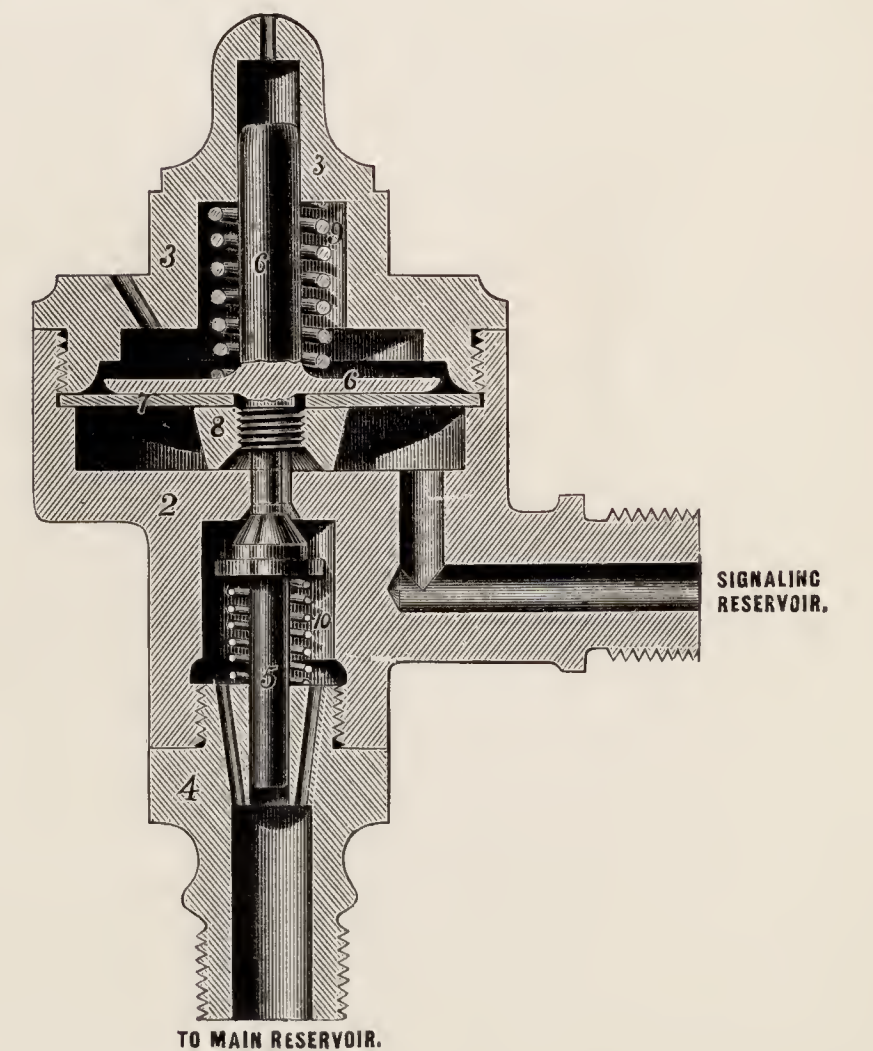


FIG. 3.

DETAILS OF SIGNALING APPARATUS.

PLATE B 22.

FIGURE 1.

No.	No.
1. Car Discharge-valve, complete.	6. Spring Screw.
2. Top Cap.	7. Valve Lever.
3. Bottom Cap.	8. Lever Pin.
4. Slide-valve.	9. Spring.
5. Slide-valve Spring.	

FIGURE 2.

No.	No.
1. Signaling-valve, complete.	8. Upper Diaphragm-plate.
2. Lower Diaphragm-case.	9. Lower Diaphragm-plate.
3. Upper Diaphragm-case.	10. Diaphragm.
4. Lower-cap Nut.	11. Rubber Gasket.
5. Valve and Stem.	12. Diaphragm Spring.
6. Feed-valve.	13. Eye-bolt.
7. Feed-valve Nut.	14. Eye-bolt Nut.

FIGURE 3.

No.	No.
1. Reducing-valve, complete.	6. Diaphragm Plate.
2. Valve-body.	7. Diaphragm.
3. Upper Cap.	8. Diaphragm Nut.
4. Lower Cap.	9. Diaphragm Spring.
5. Supply-valve.	10. Supply-valve Spring.

In ordering detached parts for repairs, please give the plate and number of each piece accurately, to avoid errors.

TRAIN SIGNALING APPARATUS.

WE have for a number of years given attention to the question of signaling from the various cars to the engineer by the use of compressed air, and have perfected the arrangement which we illustrate on Plate B22, and which is now in use on the entire Pennsylvania Railroad equipment, as well as several other lines. A separate line of pipe extends throughout the train, connected between the cars by hose and couplings; located in a convenient place in each car is a small valve, Fig. 1, the handle of which is connected to a cord running along the inside of the car, in the position usually occupied by the bell-cord. On the engine is a small reservoir, to one end of which is fastened the signaling-valve, shown in Fig. 2. A second opening in this valve leads to the main signaling-pipe, and a third opening to a small whistle located in any convenient place on the engine. The main signaling-pipe receives air from the main reservoir through a reducing-valve, Fig. 3, which is so constructed that, notwithstanding a great variation of the pressure in the main reservoir, a constant moderate pressure of about fifteen pounds per square inch is maintained in the main signaling-pipe throughout the train, in the signaling-reservoir, and in the signaling-valve. This signaling-valve has a diaphragm, No. 10, dividing the valve into two chambers, A and B, the lower chamber being in communication with the signaling-reservoir, and the upper chamber with the main pipe. This diaphragm is so arranged that it allows air to pass freely from the main pipe to the signaling-reservoir, so that an equal pressure is usually maintained in both. When it is desired to give a signal, the car-valve, Fig. 1, is opened by pulling the cord, which reduces the pressure in the main pipe; the pressure in the reservoir, being greater, then moves the diaphragm in such a manner as to carry the valve 5 away from its seat, which permits a portion of the air in the reservoir to escape to the whistle and give a signal to the engineer.

Signals can be given at the rate of four or five per second with great certainty. If the train breaks in two, the whistle is blown loudly for a con-

siderable time. We furnish the apparatus complete, including pipe and couplings, at \$20 per car and \$35 per engine.

We believe that the ease and certainty with which signals can be given will quite justify the above expenditure,—in fact, we know that it will work its way into general use as soon as its merits are fully known. The present bell-cord has been submitted to patiently for years, simply because heretofore a satisfactory substitute has not been offered, notwithstanding repeated efforts in this direction.

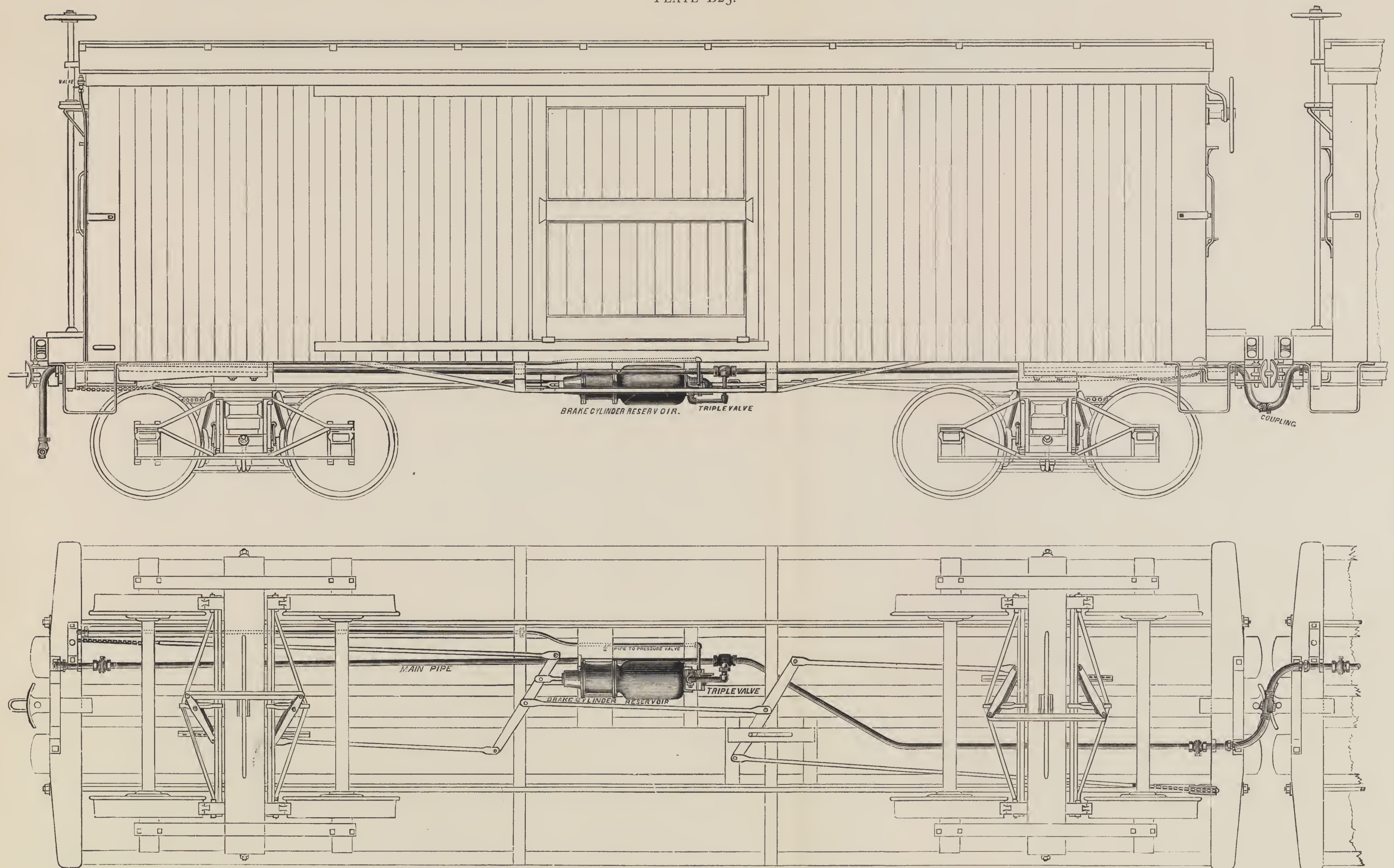
FREIGHT-BRAKES.

PLATE B23 illustrates our automatic freight-brake, which has been successfully used upon trains of fifty cars. The operation of this brake is in all respects similar to that of the passenger-brake previously described; the triple valve, brake-cylinder, and reservoir are, however, all bolted together, thus avoiding the pipe connections usually employed with the passenger apparatus. The triple valve operates in precisely the same manner, and therefore no description is necessary. The pump best suited for supplying air for the freight-brake is that shown on Plate B7, the capacity of which is about double that of the standard pump for passenger engines. After a long experience, we have become satisfied that a non-automatic brake cannot be made to work upon more than from ten to twelve cars with any satisfaction, while we have found, as stated above, that it is possible to work trains of fifty cars with the automatic brake without difficulty. With the non-automatic brake the air is stored upon the engine and transmitted back through the pipe, and consequently there is a great loss of time both in putting on and taking off the brakes. With the automatic brake, the air is stored upon each car ready for use, and this supply is readily brought into action by a slight reduction of pressure in the main pipe, which reduction requires the movement of a trifling quantity of air as compared with that used for setting a non-automatic brake. A careful analysis of accidents shows that a much greater number will be prevented by having a brake which will act of its own accord in case of the train breaking in two. We do not pretend to offer our brake in competition with the so-called buffer or concussion brakes, as these latter can never be made to apply themselves automatically when the train breaks in two, and therefore will never fulfill the necessary requirements, while recent experiments show that they are useless on trains of any considerable length.

The price for these brakes, when used for freight cars only, will be \$50 per set. The price for the apparatus for the engine is the same as for

FREIGHT-BRAKES.

PLATE B23.



that used on a passenger engine, the same parts being furnished excepting the larger pump shown on Plate B7.

This apparatus is provided with a *pressure retaining valve* for use on long and steep gradients. This is simply a weighted valve connected to the discharge port of the triple valve and provided with a small cock which, in one position, permits the air to escape freely, and in the other forces it to pass under the weighted valve. In descending long grades, the cock is turned to the latter position, and the weighted valve retains a pressure of ten pounds, which keeps the train under control when the brakes are released to recharge the reservoirs. On slight grades, or a level, the cock must be turned to the first position, permitting the air to escape freely without raising the valve.

In fitting our apparatus to the cars, more or less difficulty has been experienced, owing to carelessness in permitting the scales and dirt to get into the triple valves, and we have designed what we call a car drain-cup (No. 27, Plate B5), so constructed that it will be impossible for sand, grit, or moisture to enter the triple valves. This takes the place of a common "T" piece usually inserted in the main pipe to make the connection to the triple valve.

A section of the triple valve, brake-cylinder, and reservoir is shown on Plate B24, and an enlarged sectional view of the triple valve is shown on Plate B25.



CYLINDER AND TRIPLE VALVE.

DETAILS OF FREIGHT-BRAKE CYLINDER.

PLATE B 24.

No.	No.
1. Reservoir, Cylinder, and Triple Valve, complete.	6. Piston Follower.
2. Cylinder Body.	7. Piston Packing-leather.
3. Piston and Rod.	8. Packing-leather Expander.
4. Front Head.	9. Release Spring.
5. Piston Follower Belt.	10. Reservoir.
	11. Triple Valve, complete.

DETAILS OF FREIGHT-BRAKE TRIPLE VALVE.

PLATE B 25.

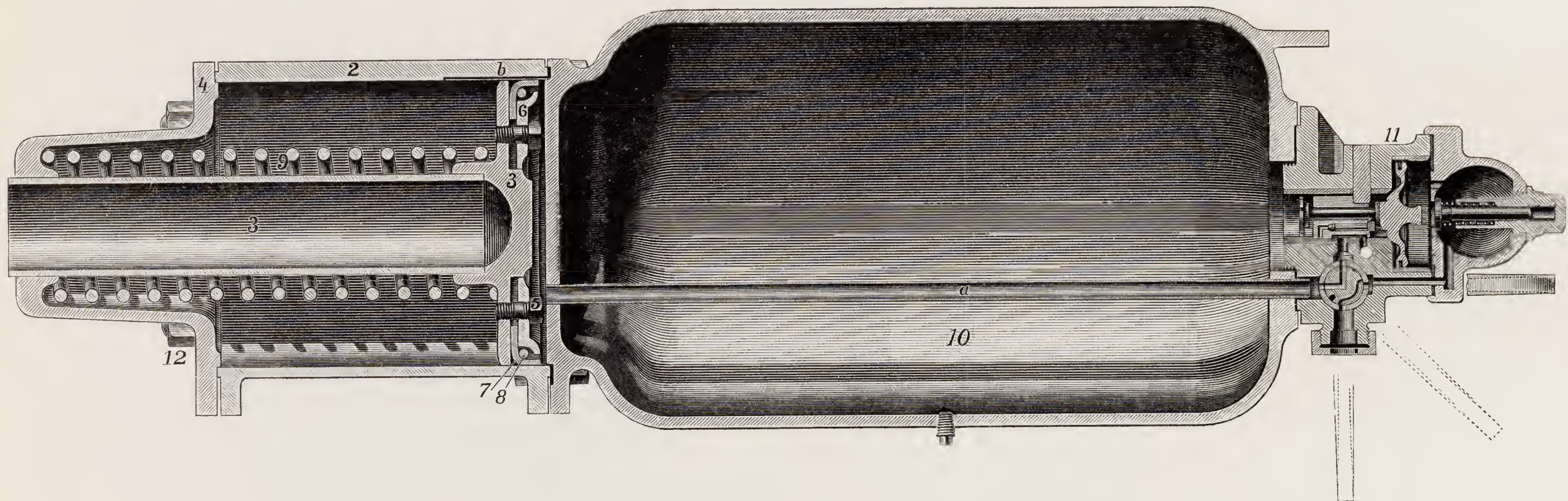
No.	No.
1. Freight-brake Triple Valve, complete.	7. Graduating-valve.
2. Valve-case.	8. Graduating-stem.
3. Drain-cup.	9. Graduating-spring.
4. Four-way Cock Plug.	10. Graduating-stem Nut.
5. Piston.	11. Triple-valve Gasket.
6. Slide-valve.	12. Piston Packing-ring.

In ordering detached parts for repairs, please give the plate and number of each piece accurately, to avoid errors.

FREIGHT BRAKE.

PLATE B24.

Fig. 1.



PRESSURE RETAINING VALVE.

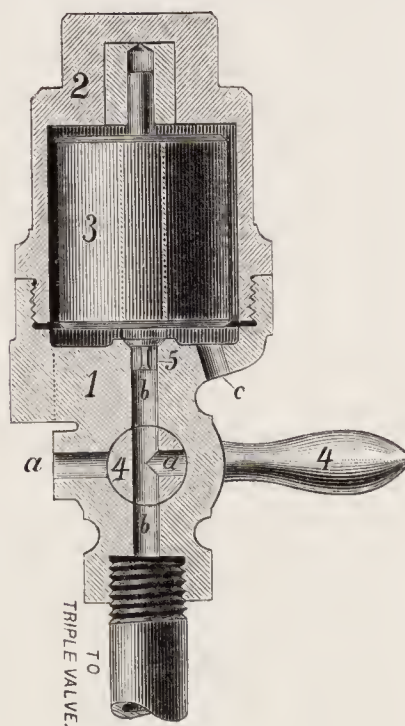
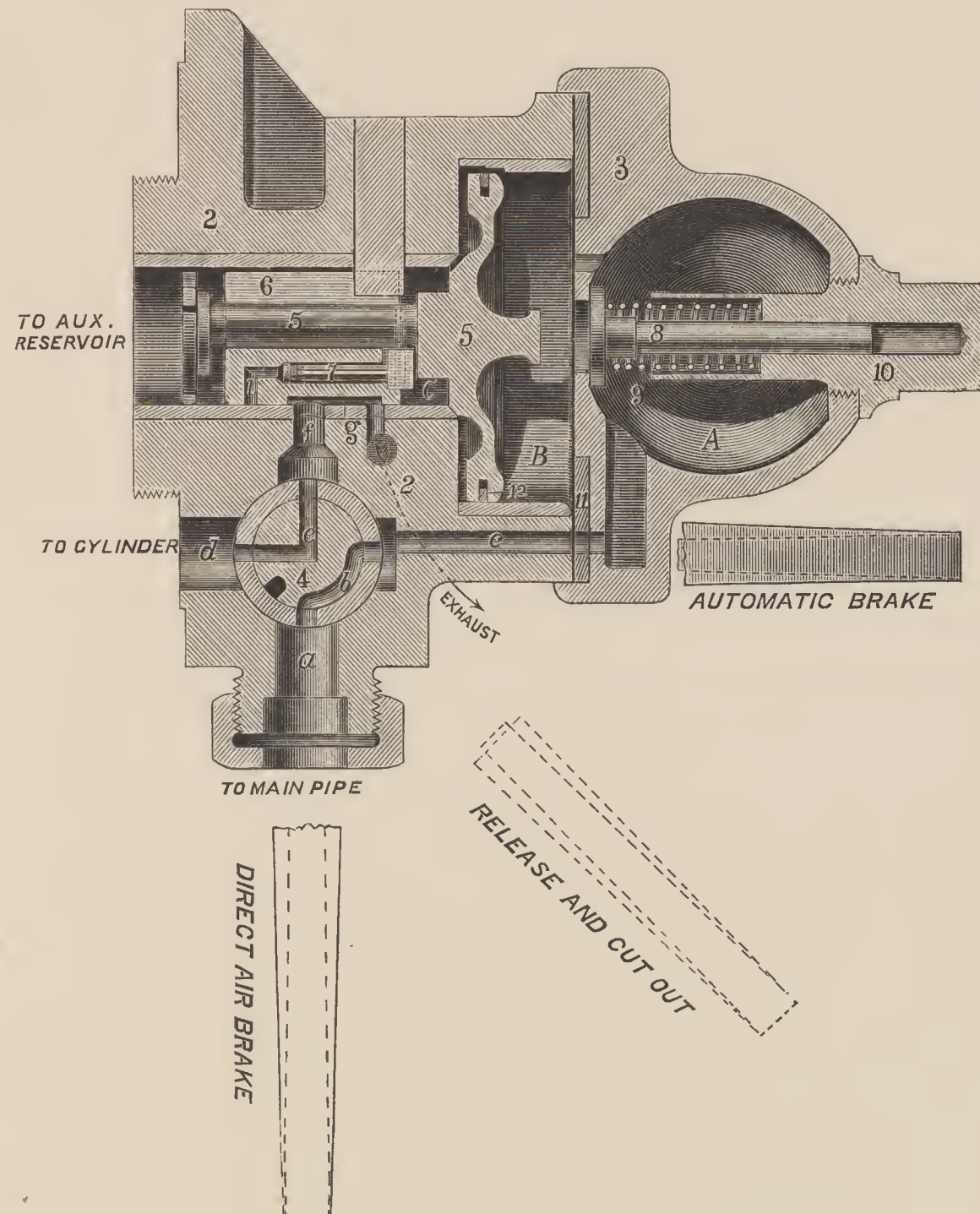


Fig. 2.

FREIGHT-BRAKE TRIPLE VALVE.

PLATE B 25.





Appendix.



APPENDIX.

—10701—

INSTRUCTIONS.

GENERAL. In making up trains, all couplings must be united so that the brakes will apply throughout the entire train. The cocks in the brake-pipe must all be opened (handles pointing down), except that on the rear of the last car, which must be closed.

In detaching engines or cars, the couplings must invariably be parted by hand; the cocks in the main brake-pipes must always be closed *before* separating the couplings, to prevent application of the brakes.

If the brakes are applied when the engine is not attached to the train or car, they can be released by opening the release-cock usually put in the end of the brake-cylinder.

The adjustment of the brake gear should be such that, when the brakes are full on, the pistons in the brake-cylinders will not have traveled to exceed eight or nine inches. This will allow for wear of shoes, stretching of rods, springing of brake-beams, etc. In narrow-gauge freight apparatus the adjustment must be such that the piston will not travel more than five or six inches.

Great care must be exercised, when taking up the slack in the brake connections, to have the levers and pistons pushed back to their proper places, and the slack taken up by the under connections or dead levers.

The brake cylinders must always be kept clean, so that they will readily release when the air has been discharged, and should be oiled once in three months. The last date of oiling should be marked on the cylinder with chalk.

For the automatic brake, the handle of the four-way cock must be turned horizontally. If turned down, it will be changed to the simple air-brake; if turned midway between these two positions, it will close communication with the brake-cylinder and reservoir, and should be so turned when desirable to have the brakes out of use on any particular car, on account of the breaking of rods, etc. It is very important, in order to avoid detentions, to keep the handles of these four-way cocks in their proper positions.

In cold weather the triple valve should be drained frequently, to let out any water that may have collected. Slack the bottom nut of the triple valve about half a turn, let the water escape, and screw it up again. The main pipe on the tender should be provided with a separate drain-cup with a cock, so that it can be drained daily in cold weather. The valve for the application of the brakes from the inside of the car should be kept tight, and must be examined by the inspectors.

ENGINEERS must see that the steam-cylinder is kept well lubricated; that the air-cylinder is sparingly lubricated with a small quantity of 28° gravity West Virginia well oil (tallow or lard oil must not be used in the air-cylinder); that the pump is constantly run, but never faster than is necessary to maintain the required air pressure; and that air from fifty to sixty pounds pressure for low speed or way trains, and from seventy to eighty pounds pressure for express trains, is carried.

For ordinary stops, the brakes should be applied lightly by opening the valve or cock, and closing it gently when the pressure has been reduced from four to eight pounds on the gauge.

The brakes are fully applied when the pressure as shown on the gauge is reduced twenty pounds. Any further reduction is a waste of air.

In releasing the brakes, the handle of the brake-valve must be moved quite against the stop, and be kept there for about ten seconds, and then moved back against the intermediate stop, which is the feed position, and where it must remain while the train is running.

Engineers, upon finding that the brakes have been applied by the train men, or automatically, must at once aid in stopping the train by turning the handle of the brake-valve toward the right, thus preventing escape of air from the main reservoir.

The shoes of the driving-wheel brakes should be so adjusted, by means of the cam screws, that the pistons move up from three to four inches when the brakes are applied.

It is important to drain the water out of the main reservoir once a week, especially in winter-time, and oftener if the pump-rod is not kept well packed.

If cars having different air pressures be coupled together, the brakes will apply themselves on those which have the highest pressure. To insure the certain release of all of the brakes in the train, and also that trains may be charged quickly, the engineer must carry the maximum pressure in the main reservoir before connecting to a train, and then put the handle of his brake-valve in the release position until the train is charged with air. If the brakes on the engine and tender thus apply themselves by being coupled to a train not charged, they should at once be taken off by opening the brake-cylinder release-cock, which should be arranged to be worked from the foot-plate.

TRAIN MEN. After making up or adding to a train, or after a change of engines, the rear brakeman shall ascertain whether the brake is connected throughout the train.

When hose couplings are not used for connecting the brakes between two vehicles, they must be attached to their coupling-hooks, to prevent dirt or water from getting into the pipe. This is very important.

When there is occasion to apply the brakes from the cars, the valve must be held open to allow the air to escape until the train is brought to a stand-still; but this method of application should only be used in cases of emergency.

Train men must in all cases see that the hand-brakes are off before starting.

Before detaching the engine or any cars, the brakes must be fully released on the whole train. Neglecting this precaution, or setting the brakes by opening a valve or cock when the engine is detached, may cause serious inconvenience in switching.

The pipes and joints must be kept tight, and when leaks are discovered they should be corrected, if serious, before the car is again used.

HOW TO APPLY AND RELEASE THE WESTINGHOUSE AUTOMATIC BRAKE.

THE brakes, as has been explained, are applied when the pressure in the brake-pipe is suddenly reduced, and released when the pressure is restored.

It is of very great importance that every engineer should bear in mind that the air pressure may sometimes reduce slowly, owing to the steam pressure getting low, or from the stopping of the pump, or from a leakage in some of the pipes when one or more cars are detached for switching purposes, and that in consequence it has been found absolutely necessary to provide each cylinder with what is called a leakage groove, preventing the application of the brakes when the pressure is slowly reduced, as would result from any of the above causes.

This provision against the accidental application of the brakes must be taken into consideration, or else it will sometimes happen that all of the brakes will not be applied when such is the intention, simply because the air has been discharged so slowly from the brake-pipe that it only represents a considerable leakage, and thus allows the air under some cars to be wasted.

It is thus very essential to discharge enough air in the first instance, and with sufficient rapidity, to cause all of the leakage-grooves to be closed, when they will remain closed until the brakes have been released. In no case should the reduction in the brake-pipe for closing the leakage-grooves be less than four or five pounds, which will move all pistons out so that the brake-shoes will be only slightly bearing against the wheels. After this first reduction the pressure can be reduced to suit the circumstances.

On a long train, if the engineer's brake-valve be opened suddenly, and then quickly closed, the pressure in the brake-pipe, as indicated by the gauge, will be suddenly and considerably reduced on the engine, and will

then be increased by the air pressure coming from the rear of the train; hence it is important to always close the engineer's brake-valve slowly, and in such a manner that the pressure as indicated by the gauge will not be increased, or else the brakes on the engine and tender, and sometimes on the first one or two cars, will come off when they should remain on. It is likewise very important, while the brakes are on, to keep the engineer's brake-valve in such a position that the brake-pipe pressure cannot be increased by leakage from the main reservoir, for any increase of pressure in the brake-pipe causes the brakes to come off.

On long down-grades it is important to be able to control the speed of the train, and at the same time to maintain a good working pressure. This is easily accomplished where the pressure-retaining valve is not in use, by running the pump at a good speed, so that the main reservoir will accumulate a high pressure while the brakes are on. When, after using the brake some time, the pressure has been reduced to sixty pounds, the train pipes and reservoirs should be recharged as much as possible before the speed has increased to the maximum allowed. A greater time for recharging is obtained by considerably reducing the speed of the train just before recharging and by taking advantage of the variation in the grades.

There should not be any safety-valve or leaks in the main reservoir, otherwise the necessary surplus pressure for quickly recharging cannot be obtained.

To release the brakes with certainty, it is important to have a higher pressure in the main reservoir than in the main pipe. If an engineer feels that some of his brakes are not off, it is best to turn the handle of the engineer's brake-valve just far enough to shut off the main reservoir and then pump up fifteen or twenty pounds extra, which will insure the release of all of the brakes; all of this can be done while the train is in motion.

For ordinary stops, great economy in the use of air is effected by, in the first instance, letting out from eight to twelve pounds pressure while the train is at speed, taking care to begin a sufficient distance from the station.

BRAKE POWER.

TO obtain the best results, it is important to have the braking force proportioned to the weight of the car, or, more particularly speaking, to the load carried by those wheels upon which brakes act. After long experience, it has been decided to recommend such a proportion of brake-levers that a pressure of 50 pounds per square inch on the brake-piston will bring a force against the brake-blocks on each pair of wheels nearly equal to the load carried by them; thus, owing to a great variation of cars, it is necessary to have brake-levers proportioned to the weight of each car.

For convenience, it has been found best to cut the brake connection which joins the brakes of both trucks, and to interpose at this point the brake cylinder, having with it two levers and a tie-rod. With this arrangement it is only necessary to get the proper proportion of these cylinder levers.

The following rules will enable those whose duty it is to attach brakes to proportion the levers so as to carry out the foregoing recommendation.

RULES FOR CALCULATING CAR-LEVERS.

THE air pressure is rated at fifty (50) pounds per square inch on piston, when the brakes are fully applied. (50 pounds per square inch gives about 4000 pounds for 10-inch cylinder, and 2500 pounds for 8-inch cylinder.)

To find the leverage required — Divide the weight on track under wheels to which brakes are applied, by the *whole* pressure on piston.

To find proportion of brake-beam levers — Divide the *whole* length of lever by short end.

To find the total brake-beam leverage — Multiply proportion of lever by two (2) for the *Hodge* system, and by four (4) for the *Stevens*.

To find proportion of cylinder lever — Multiply the whole length of lever by either the required leverage or the *total* brake-beam leverage, and divide by the sum of both: the result will give the length of one end of the lever.

If the required leverage is greater than the *total* brake-beam leverage, the long end of lever must go next to the cylinder; if less, the short end must go next to the cylinder.

Dead levers must be made in the same proportion as the other truck levers.

EXAMPLE — HODGE SYSTEM.

Weight of car	36,000 pounds.
Total pressure on 10-inch piston	4,000 "
Total length of brake-beam lever	28 inches.
Length of short end of brake-beam lever	7 "
Total length of cylinder lever	24 "

$36,000 \div 4,000 = 9$, leverage required.
 $28 \div 7 = 4 \times 2 = 8$, total brake-beam leverage.
 $24 \times 8 = 192 \div (8 + 9) = 11.3$, short end cylinder lever.
 $24 - 11.3 = 12.7$, long end cylinder lever.

EXAMPLE — STEVENS'S SYSTEM.

Total length of cylinder lever, 36 inches.
 $36,000 \div 4,000 = 9$, leverage required.
 $28 \div 7 = 4 \times 4 = 16$, total brake-beam leverage.
 $36 \times 9 = 324 \div (9 + 16) = 12.96$, short end cylinder lever.
 $36 - 12.96 = 23.04$, long end cylinder lever.



WESTINGHOUSE BRAKE APPARATUS

IS manufactured under the protection of various United States patents, which the Brake Company either own, or under which they are specially licensed.

We append hereto a list of these patents, classified with approximate accuracy, though some of them embrace features which are used in the construction of different classes of apparatus. Such patents will be enumerated only in the class to which they primarily relate, since an enumeration in each class would make the list too long.

I. WESTINGHOUSE "COMPRESSED AIR" (NON-AUTOMATIC) BRAKE PATENTS.

No.	DATE.	NAME.
88,929	April 13th, 1869	George Westinghouse, Jr.
5,504 (Re-issue)	July 29th, 1873	" "
117,841	August 8th, 1871	" "
5,505 (Re-issue)	July 29th, 1873	" "
122,544	January 9th, 1872	" "
123,067	" 23d, "	" "
124,403	March 5th, "	" "
125,639	April 9th, "	Thomas W. Welsh.
134,178	December 24th, 1872	George Westinghouse, Jr.
142,600	September 9th, 1873	" "
144,582	November 11th, "	" "
149,902	April 21st, 1874	" "
162,465	" 27th, 1875	Walter J. Ford, George Westinghouse, Jr., and Thomas W. Welsh.
166,405	August 3d, 1875	H. L. Perrine.
166,406	" " "	" "
169,575	November 2d, 1875	" "
203,647	May 14th, 1878	William G. Raoul.
216,545	June 17th, 1879	George Westinghouse, Jr.
222,803	December 23d, 1879	" "

II. WESTINGHOUSE AUTOMATIC AIR-BRAKE PATENTS.

No.	DATE.	NAME.
124,404	March 5th, 1872	George Westinghouse, Jr.
124,405	" " "	" "
134,177	December 24th, 1872	" "
138,827	May 13th, 1873	" "

No.	DATE.	NAME.
141,685	August 12th, 1873	George Westinghouse, Jr.
144,006	October 28th, "	" "
149,901	April 21st, 1874	" "
156,322	October 27th, 1874	" "
156,323	" " "	" "
160,955	March 16th, 1875	James R. Reniff.
163,242	May 11th, "	Charles H. Perkins.
168,359	October 5th, "	George Westinghouse, Jr.
172,064	January 11th, 1876	" "
193,279	July 17th, 1877	H. L. Perrine.
214,337	April 15th, 1879	George Westinghouse, Jr.
180,179	July 25th, 1876	" "
214,602	April 22d, 1879	" "
214,603	" " "	" "
217,836	July 22d, "	" "
217,838	" " "	" "
218,149	August 5th, "	" "
218,150	" " "	" "
220,556	October 14th, 1879	" "
225,898	March 23d, 1880	" "
235,922	December 28th, 1880	" "

III. HOSE-COUPLING PATENTS.

No.	DATE.	NAME.
64,437	May 7th, 1867	Barney Mee.
109,695	November 29th, 1870	George Westinghouse, Jr.
115,917	June 13th, 1871	Levi Wharton.
116,655	July 4th, "	George Westinghouse, Jr.
122,873	January 16th, 1872	Thomas W. Welsh.
136,396	March 4th, 1873	George Westinghouse, Jr.
136,397	" " "	" "
136,631	" 11th, "	" "
146,367	January 13th, 1874	John Y. Smith.
157,951	December 22d, "	George Westinghouse, Jr.
8,291 (Re-issue)	June 18th, 1878	" "
166,489	August 10th, 1875	" "
214,334	April 15th, 1879	H. H. Westinghouse.
214,335	" " "	George Westinghouse, Jr.
214,336	" " "	" "
221,987	November 25th, 1879	Thomas W. Welsh.
224,256	February 3d, 1879	Charles G. Welch.
236,388	January 4th, 1881	George Westinghouse, Jr.

IV. DRIVING-WHEEL BRAKE PATENTS.

No.	DATE.	NAME.
144,005	October 28th, 1873	George Westinghouse, Jr.
147,212	February 3d, 1874	" "
175,886	April 11th, 1876	" "

V. AIR-PUMP AND ENGINE PATENTS.

No.	DATE.	NAME.
106,899	August 30th, 1870	George Westinghouse, Jr.
115,668	June 6th, 1871	" "
131,985	October 8th, 1872	" "
138,828	May 13th, 1873	" "
159,782	February 16th, 1875	" "
136,806	March 18th, 1873	John Bailey.
157,671	December 15th, 1874	" "
183,206	October 10th, 1876	James R. Reniff.

VI. VACUUM-BRAKE PATENTS (NON-AUTOMATIC).

No.	DATE.	NAME.
28,670 (Extended)	June 12th, 1860	Nehemiah Hodge.
8,971	November 18th, 1879	" "
114,083	April 25th, 1871	Henry W. Adams.
115,667	June 6th, "	George Westinghouse, Jr.
2,506 (Re-issue)	July 29th, 1873	" "
9,478	November 23d, 1880	" "
129,868	July 23d, 1872	John Y. Smith.
130,323	August 6th, 1872	" "
136,779	March 11th, 1873	" "
136,780	" " "	" "
136,781	" " "	" "
160,903	May 16th, 1875	George Westinghouse, Jr.
163,612	" 25th, "	John Y. Smith.
169,118	September 25th, 1875	George Westinghouse, Jr.

VII. WESTINGHOUSE AUTOMATIC VACUUM-BRAKE PATENTS.

No.	DATE.	NAME.
134,408	December 31st, 1872	George Westinghouse, Jr.
6,948 (Re-issue)	February 22d, 1876	" "
217,837	July 22d, 1879	" "

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